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(54) Title: <b>SYSTEMS AND METHODS FOR SECURE TRANSACTION MANAGEMENT AND ELECTRONIC RIGHTS PROTECTION</b>		
(57) Abstract <p>The present invention provides systems and methods for electronic commerce including secure transaction management and electronic rights protection. Electronic appliances such as computers employed in accordance with the present invention help to ensure that information is accessed and used only in authorized ways, and maintain the integrity, availability, and/or confidentiality of the information. Secure subsystems used with such electronic appliances provide a distributed virtual distribution environment (VDE) that may enforce a secure chain of handling and control, for example, to control and/or meter or otherwise monitor use of electronically stored or disseminated information. Such a virtual distribution environment may be used to protect rights of various participants in electronic commerce and other electronic or electronic-facilitated transactions. Secure distributed and other operating system environments and architectures, employing, for example, secure semiconductor processing arrangements that may establish secure, protected environments at each node. These techniques may be used to support an end-to-end electronic information distribution capability that may be used, for example, utilizing the "electronic highway".</p>		

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## SYSTEMS AND METHODS FOR SECURE TRANSACTION MANAGEMENT AND ELECTRONIC RIGHTS PROTECTION

### Field(s) of the Invention(s)

This invention generally relates to computer and/or  
electronic security.

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More particularly, this invention relates to systems and  
techniques for secure transaction management. This invention  
also relates to computer-based and other electronic appliance-  
based technologies that help to ensure that information is  
10 accessed and/or otherwise used only in authorized ways, and  
maintains the integrity, availability, and/or confidentiality of  
such information and processes related to such use.

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The invention also relates to systems and methods for  
protecting rights of various participants in electronic commerce  
and other electronic or electronically-facilitated transactions.

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The invention also relates to secure chains of handling and  
control for both information content and information employed to  
regulate the use of such content and consequences of such use. It  
also relates to systems and techniques that manage, including  
meter and/or limit and/or otherwise monitor use of electronically  
stored and/or disseminated information. The invention

particularly relates to transactions, conduct and arrangements that make use of, including consequences of use of, such systems and/or techniques.

5           The invention also relates to distributed and other operating systems, environments and architectures. It also generally relates to secure architectures, including, for example, tamper-resistant hardware-based processors, that can be used to establish security at each node of a distributed system.

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#### **Background and Summary of the Invention(s)**

Telecommunications, financial transactions, government processes, business operations, entertainment, and personal business productivity all now depend on electronic appliances.

15       Millions of these electronic appliances have been electronically connected together. These interconnected electronic appliances comprise what is increasingly called the "information highway." Many businesses, academicians, and government leaders are concerned about how to protect the rights of citizens and

20       organizations who use this information (also "electronic" or "digital") highway.

#### **Electronic Content**

Today, virtually anything that can be represented by

25       words, numbers, graphics, or system of commands and

instructions can be formatted into electronic digital information.

Television, cable, satellite transmissions, and on-line services transmitted over telephone lines, compete to distribute digital information and entertainment to homes and businesses. The

5 owners and marketers of this content include software developers, motion picture and recording companies, publishers of books, magazines, and newspapers, and information database providers. The popularization of on-line services has also enabled the individual personal computer user to participate as a content  
10 provider. It is estimated that the worldwide market for electronic information in 1992 was approximately \$40 billion and is expected to grow to \$200 billion by 1997, according to Microsoft Corporation. The present invention can materially enhance the revenue of content providers, lower the distribution costs and the  
15 costs for content, better support advertising and usage information gathering, and better satisfy the needs of electronic information users. These improvements can lead to a significant increase in the amount and variety of electronic information and the methods by which such information is distributed.

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The inability of conventional products to be shaped to the needs of electronic information providers and users is sharply in contrast to the present invention. Despite the attention devoted by a cross-section of America's largest telecommunications,  
25 computer, entertainment and information provider companies to

some of the problems addressed by the present invention, only the present invention provides commercially secure, effective solutions for configurable, general purpose electronic commerce transaction/distribution control systems.

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### **Controlling Electronic Content**

The present invention provides a new kind of "virtual distribution environment" (called "VDE" in this document) that secures, administers, and audits electronic information use. VDE also features fundamentally important capabilities for managing content that travels "across" the "information highway." These capabilities comprise a rights protection solution that serves all electronic community members. These members include content creators and distributors, financial service providers, end-users, and others. VDE is the first general purpose, configurable, transaction control/rights protection solution for users of computers, other electronic appliances, networks, and the information highway.

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A fundamental problem for electronic content providers is extending their ability to control the use of proprietary information. Content providers often need to limit use to authorized activities and amounts. Participants in a business model involving, for example, provision of movies and advertising on optical discs may include actors, directors, script and other

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writers, musicians, studios, publishers, distributors, retailers, advertisers, credit card services, and content end-users. These participants need the ability to embody their range of agreements and requirements, including use limitations, into an "extended" agreement comprising an overall electronic business model. This extended agreement is represented by electronic content control information that can automatically enforce agreed upon rights and obligations. Under VDE, such an extended agreement may comprise an electronic contract involving all business model participants. Such an agreement may alternatively, or in addition, be made up of electronic agreements between subsets of the business model participants. Through the use of VDE, electronic commerce can function in the same way as traditional commerce—that is commercial relationships regarding products and services can be shaped through the negotiation of one or more agreements between a variety of parties.

Commercial content providers are concerned with ensuring proper compensation for the use of their electronic information. Electronic digital information, for example a CD recording, can today be copied relatively easily and inexpensively. Similarly, unauthorized copying and use of software programs deprives rightful owners of billions of dollars in annual revenue according to the International Intellectual Property Alliance. Content providers and distributors have devised a number of limited

function rights protection mechanisms to protect their rights.  
Authorization passwords and protocols, license servers,  
“lock/unlock” distribution methods, and non-electronic  
contractual limitations imposed on users of shrink-wrapped  
5 software are a few of the more prevalent content protection  
schemes. In a commercial context, these efforts are inefficient  
and limited solutions.

Providers of “electronic currency” have also created  
10 protections for their type of content. These systems are not  
sufficiently adaptable, efficient, nor flexible enough to support  
the generalized use of electronic currency. Furthermore, they do  
not provide sophisticated auditing and control configuration  
capabilities. This means that current electronic currency tools  
15 lack the sophistication needed for many real-world financial  
business models. VDE provides means for anonymous currency  
and for “conditionally” anonymous currency, wherein currency  
related activities remain anonymous except under special  
circumstances.

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#### **VDE Control Capabilities**

VDE allows the owners and distributors of electronic  
digital information to reliably bill for, and securely control, audit,  
25 and budget the use of, electronic information. It can reliably



detect and monitor the use of commercial information products.

VDE uses a wide variety of different electronic information delivery means: including, for example, digital networks, digital broadcast, and physical storage media such as optical and magnetic disks. VDE can be used by major network providers, hardware manufacturers, owners of electronic information, providers of such information, and clearinghouses that gather usage information regarding, and bill for the use of, electronic information.

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VDE provides comprehensive and configurable transaction management, metering and monitoring technology. It can change how electronic information products are protected, marketed, packaged, and distributed. When used, VDE should result in higher revenues for information providers and greater user satisfaction and value. Use of VDE will normally result in lower usage costs, decreased transaction costs, more efficient access to electronic information, re-usability of rights protection and other transaction management implementations, greatly improved flexibility in the use of secured information, and greater standardization of tools and processes for electronic transaction management. VDE can be used to create an adaptable environment that fulfills the needs of electronic information owners, distributors, and users; financial clearinghouses; and usage information analyzers and resellers.

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### **Rights and Control Information**

In general, the present invention can be used to protect the rights of parties who have:

- 5           (a)   proprietary or confidentiality interests in electronic information. It can, for example, help ensure that information is used only in authorized ways;
- 10           (b)   financial interests resulting from the use of electronically distributed information. It can help ensure that content providers will be paid for use of distributed information; and
- 15           (c)   interests in electronic credit and electronic currency storage, communication, and/or use including electronic cash, banking, and purchasing.

Protecting the rights of electronic community members involves a broad range of technologies. VDE combines these technologies in a way that creates a "distributed" electronic rights protection "environment." This environment secures and protects transactions and other processes important for rights protection. VDE, for example, provides the ability to prevent, or impede, interference with and/or observation of, important rights related transactions and processes. VDE, in its preferred

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embodiment, uses special purpose tamper resistant Secure Processing Units (SPUs) to help provide a high level of security for VDE processes and information storage and communication.

5           The rights protection problems solved by the present invention are electronic versions of basic societal issues. These issues include protecting property rights, protecting privacy rights, properly compensating people and organizations for their work and risk, protecting money and credit, and generally  
10       protecting the security of information. VDE employs a system that uses a common set of processes to manage rights issues in an efficient, trusted, and cost-effective way.

          VDE can be used to protect the rights of parties who create  
15       electronic content such as, for example: records, games, movies, newspapers, electronic books and reference materials, personal electronic mail, and confidential records and communications. The invention can also be used to protect the rights of parties who provide electronic products, such as publishers and  
20       distributors; the rights of parties who provide electronic credit and currency to pay for use of products, for example, credit clearinghouses and banks; the rights to privacy of parties who use electronic content (such as consumers, business people, governments); and the privacy rights of parties described by  
25       electronic information, such as privacy rights related to

information contained in a medical record, tax record, or  
personnel record.

In general, the present invention can protect the rights of  
5 parties who have:

(a) commercial interests in electronically distributed  
information -- the present invention can help ensure,  
for example, that parties, will be paid for use of  
distributed information in a manner consistent with  
10 their agreement;

(b) proprietary and/or confidentiality interests in  
electronic information -- the present invention can,  
for example, help ensure that data is used only in  
15 authorized ways;

(c) interests in electronic credit and electronic currency  
storage, communication, and/or use -- this can  
include electronic cash, banking, and purchasing;  
20 and

(d) interests in electronic information derived, at least  
in part, from use of other electronic information.

25 **VDE Functional Properties**

VDE is a cost-effective and efficient rights protection solution that provides a unified, consistent system for securing and managing transaction processing. VDE can:

- 5           (a)    audit and analyze the use of content,
- (b)    ensure that content is used only in authorized ways,  
                    and
- 10           (c)    allow information regarding content usage to be used  
                    only in ways approved by content users.

In addition, VDE:

- 15           (a)    is very configurable, modifiable, and re-usable;
- (b)    supports a wide range of useful capabilities that may  
                    be combined in different ways to accommodate most  
                    potential applications;
- 20           (c)    operates on a wide variety of electronic appliances  
                    ranging from hand-held inexpensive devices to large  
                    mainframe computers;

- (d) is able to ensure the various rights of a number of different parties, and a number of different rights protection schemes, simultaneously;
- 5 (e) is able to preserve the rights of parties through a series of transactions that may occur at different times and different locations;
- 10 (f) is able to flexibly accommodate different ways of securely delivering information and reporting usage; and
- 15 (g) provides for electronic analogues to "real" money and credit, including anonymous electronic cash, to pay for products and services and to support personal (including home) banking and other financial activities.

VDE economically and efficiently fulfills the rights protection needs of electronic community members. Users of VDE will not require additional rights protection systems for different information highway products and rights problems—nor will they be required to install and learn a new system for each new information highway application.

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VDE provides a unified solution that allows all content creators, providers, and users to employ the same electronic rights protection solution. Under authorized circumstances, the participants can freely exchange content and associated content control sets. This means that a user of VDE may, if allowed, use the same electronic system to work with different kinds of content having different sets of content control information. The content and control information supplied by one group can be used by people who normally use content and control information supplied by a different group. VDE can allow content to be exchanged "universally" and users of an implementation of the present invention can interact electronically without fear of incompatibilities in content control, violation of rights, or the need to get, install, or learn a new content control system.

The VDE securely administers transactions that specify protection of rights. It can protect electronic rights including, for example:

- (a) the property rights of authors of electronic content,
- (b) the commercial rights of distributors of content,
- (c) the rights of any parties who facilitated the distribution of content,

- (d) the privacy rights of users of content,
- (e) the privacy rights of parties portrayed by stored and/or distributed content, and
- (f) any other rights regarding enforcement of electronic agreements.

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VDE can enable a very broad variety of electronically enforced commercial and societal agreements. These agreements can include electronically implemented contracts, licenses, laws, regulations, and tax collection.

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#### **Contrast With Traditional Solutions**

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Traditional content control mechanisms often require users to purchase more electronic information than the user needs or desires. For example, infrequent users of shrink-wrapped software are required to purchase a program at the same price as frequent users, even though they may receive much less value from their less frequent use. Traditional systems do not scale cost according to the extent or character of usage and traditional systems can not attract potential customers who find that a fixed price is too high. Systems using traditional mechanisms are also not normally particularly secure. For example, shrink-wrapping

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does not prevent the constant illegal pirating of software once removed from either its physical or electronic package.

Traditional electronic information rights protection systems are often inflexible and inefficient and may cause a content provider to choose costly distribution channels that increase a product's price. In general these mechanisms restrict product pricing, configuration, and marketing flexibility. These compromises are the result of techniques for controlling information which cannot accommodate both different content models and content models which reflect the many, varied requirements, such as content delivery strategies, of the model participants. This can limit a provider's ability to deliver sufficient overall value to justify a given product's cost in the eyes of many potential users. VDE allows content providers and distributors to create applications and distribution networks that reflect content providers' and users' preferred business models. It offers users a uniquely cost effective and feature rich system that supports the ways providers want to distribute information and the ways users want to use such information. VDE supports content control models that ensure rights and allow content delivery strategies to be shaped for maximum commercial results.

### **Chain of Handling and Control**

VDE can protect a collection of rights belonging to various parties having in rights in, or to, electronic information. This information may be at one location or dispersed across (and/or moving between) multiple locations. The information may pass through a "chain" of distributors and a "chain" of users. Usage information may also be reported through one or more "chains" of parties. In general, VDE enables parties that (a) have rights in electronic information, and/or (b) act as direct or indirect agents for parties who have rights in electronic information, to ensure that the moving, accessing, modifying, or otherwise using of information can be securely controlled by rules regarding how, when, where, and by whom such activities can be performed.

### **VDE Applications and Software**

VDE is a secure system for regulating electronic conduct and commerce. Regulation is ensured by control information put in place by one or more parties. These parties may include content providers, electronic hardware manufacturers, financial service providers, or electronic "infrastructure" companies such as cable or telecommunications companies. The control information implements "Rights Applications." Rights applications "run on" the "base software" of the preferred embodiment. This base software serves as a secure, flexible, general purpose foundation that can accommodate many

different rights applications, that is, many different business models and their respective participant requirements.

5 A rights application under VDE is made up of special purpose pieces, each of which can correspond to one or more basic electronic processes needed for a rights protection environment. These processes can be combined together like building blocks to create electronic agreements that can protect the rights, and may enforce fulfillment of the obligations, of electronic information users and providers. One or more providers of electronic information can easily combine selected building blocks to create a rights application that is unique to a specific content distribution model. A group of these pieces can represent the capabilities needed to fulfill the agreement(s) between users and providers. These pieces accommodate many requirements of electronic commerce including:

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! the distribution of permissions to use electronic information;

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! the persistence of the control information and sets of control information managing these permissions;

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! configurable control set information that can be selected by users for use with such information;

! data security and usage auditing of electronic  
information; and

! a secure system for currency, compensation and  
debit management.

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10 For electronic commerce, a rights application, under the  
preferred embodiment of the present invention, can provide  
electronic enforcement of the business agreements between all  
participants. Since different groups of components can be put  
together for different applications, the present invention can  
provide electronic control information for a wide variety of  
different products and markets. This means the present  
invention can provide a "unified," efficient, secure, and  
15 cost-effective system for electronic commerce and data security.  
This allows VDE to serve as a single standard for electronic  
rights protection, data security, and electronic currency and  
banking.

20 In a VDE, the separation between a rights application and  
its foundation permits the efficient selection of sets of control  
information that are appropriate for each of many different types  
of applications and uses. These control sets can reflect both  
rights of electronic community members, as well as obligations  
25 (such as providing a history of one's use of a product or paying

taxes on one's electronic purchases). VDE flexibility allows its users to electronically implement and enforce common social and commercial ethics and practices. By providing a unified control system, the present invention supports a vast range of possible transaction related interests and concerns of individuals, communities, businesses, and governments. Due to its open design, VDE allows (normally under securely controlled circumstances) applications using technology independently created by users to be "added" to the system and used in conjunction with the foundation of the invention. In sum, VDE provides a system that can fairly reflect and enforce agreements among parties. It is a broad ranging and systematic solution that answers the pressing need for a secure, cost-effective, and fair electronic environment.

#### **VDE Implementation**

The preferred embodiment of the present invention includes various tools that enable system designers to directly insert VDE capabilities into their products. These tools include an Application Programmer's Interface ("API") and a Rights Permissioning and Management Language ("RPML"). The RPML provides comprehensive and detailed control over the use of the invention's features. VDE also includes certain user interface subsystems for satisfying the needs of content providers, distributors, and users.

Information distributed using VDE may take many forms.

It may, for example, be "distributed" for use on an individual's own computer, that is the present invention can be used to provide security for locally stored data. Alternatively, VDE may  
5 be used with information that is dispersed by authors and/or publishers to one or more recipients. This information may take many forms including: movies, audio recordings, games, electronic catalog shopping, multimedia, training materials, E-mail and personal documents, object oriented libraries,  
10 software programming resources, and reference/record keeping information resources (such as business, medical, legal, scientific, governmental, and consumer databases).

Electronic rights protection provided by the present  
15 invention will also provide an important foundation for trusted and efficient home and commercial banking, electronic credit processes, electronic purchasing, true or conditionally anonymous electronic cash, and EDI (Electronic Data Interchange). VDE provides important enhancements for improving data security in  
20 organizations by providing "smart" transaction management features that can be far more effective than key and password based "go/no go" technology.

VDE normally employs an integration of cryptographic and  
25 other security technologies (e.g. encryption, digital signatures,

etc.), with other technologies including: component, distributed, and event driven operating system technology, and related communications, object container, database, smart agent, smart card, and semiconductor design technologies.

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## **I. Overview**

### **A. VDE Solves Important Problems and Fills Critical Needs**

The world is moving towards an integration of electronic information appliances. This interconnection of appliances provides a foundation for much greater electronic interaction and the evolution of electronic commerce. A variety of capabilities are required to implement an electronic commerce environment. VDE is the first system that provides many of these capabilities and therefore solves fundamental problems related to electronic dissemination of information.

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### **Electronic Content**

VDE allows electronic arrangements to be created involving two or more parties. These agreements can themselves comprise a collection of agreements between participants in a commercial value chain and/or a data security chain model for handling, auditing, reporting, and payment. It can provide efficient, reusable, modifiable, and consistent means for secure electronic content: distribution, usage control, usage payment,

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usage auditing, and usage reporting. Content may, for example, include:

5           !     financial information such as electronic currency and credit;

10           !     commercially distributed electronic information such as reference databases, movies, games, and advertising; and

          !     electronic properties produced by persons and organizations, such as documents, e-mail, and proprietary database information.

15       VDE enables an electronic commerce marketplace that supports differing, competitive business partnerships, agreements, and evolving overall business models.

20       The features of VDE allow it to function as the first trusted electronic information control environment that can conform to, and support, the bulk of conventional electronic commerce and data security requirements. In particular, VDE enables the participants in a business value chain model to create an electronic version of traditional business agreement terms and

25       conditions and further enables these participants to shape and



evolve their electronic commerce models as they believe appropriate to their business requirements.

5 VDE offers an architecture that avoids reflecting specific distribution biases, administrative and control perspectives, and content types. Instead, VDE provides a broad-spectrum, fundamentally configurable and portable, electronic transaction control, distributing, usage, auditing, reporting, and payment operating environment. VDE is not limited to being an application or application specific toolset that covers only a limited subset of electronic interaction activities and participants. Rather, VDE supports systems by which such applications can be created, modified, and/or reused. As a result, the present invention answers pressing, unsolved needs by offering a system that supports a standardized control environment which facilitates interoperability of electronic appliances, interoperability of content containers, and efficient creation of electronic commerce applications and models through the use of a programmable, secure electronic transactions management foundation and reusable and extensible executable components. VDE can support a single electronic "world" within which most forms of electronic transaction activities can be managed.

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To answer the developing needs of rights owners and content providers and to provide a system that can accommodate

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the requirements and agreements of all parties that may be involved in electronic business models (creators, distributors, administrators, users, credit providers, etc.), VDE supplies an efficient, largely transparent, low cost and sufficiently secure system (supporting both hardware/ software and software only models). VDE provides the widely varying secure control and administration capabilities required for:

1. Different types of electronic content,
2. Differing electronic content delivery schemes,
3. Differing electronic content usage schemes,
4. Different content usage platforms, and
5. Differing content marketing and model strategies.

VDE may be combined with, or integrated into, many separate computers and/or other electronic appliances. These appliances typically include a secure subsystem that can enable control of content use such as displaying, encrypting, decrypting, printing, copying, saving, extracting, embedding, distributing, auditing usage, etc. The secure subsystem in the preferred embodiment comprises one or more "protected processing

environments", one or more secure databases, and secure  
"component assemblies" and other items and processes that need  
to be kept secured. VDE can, for example, securely control  
electronic currency, payments, and/or credit management  
5 (including electronic credit and/or currency receipt,  
disbursement, encumbering, and/or allocation) using such a  
"secure subsystem."

VDE provides a secure, distributed electronic transaction  
10 management system for controlling the distribution and/or other  
usage of electronically provided and/or stored information. VDE  
controls auditing and reporting of electronic content and/or  
appliance usage. Users of VDE may include content creators who  
apply content usage, usage reporting, and/or usage payment  
15 related control information to electronic content and/or  
appliances for users such as end-user organizations, individuals,  
and content and/or appliance distributors. VDE also securely  
supports the payment of money owed (including money owed for  
content and/or appliance usage) by one or more parties to one or  
20 more other parties, in the form of electronic credit and/or  
currency.

Electronic appliances under control of VDE represent VDE  
'nodes' that securely process and control; distributed electronic  
25 information and/or appliance usage, control information

formulation, and related transactions. VDE can securely manage the integration of control information provided by two or more parties. As a result, VDE can construct an electronic agreement between VDE participants that represent a "negotiation" between, the control requirements of, two or more parties and enacts terms and conditions of a resulting agreement. VDE ensures the rights of each party to an electronic agreement regarding a wide range of electronic activities related to electronic information and/or appliance usage.

Through use of VDE's control system, traditional content providers and users can create electronic relationships that reflect traditional, non-electronic relationships. They can shape and modify commercial relationships to accommodate the evolving needs of, and agreements among, themselves. VDE does not require electronic content providers and users to modify their business practices and personal preferences to conform to a metering and control application program that supports limited, largely fixed functionality. Furthermore, VDE permits participants to develop business models not feasible with non-electronic commerce, for example, involving detailed reporting of content usage information, large numbers of distinct transactions at hitherto infeasibly low price points, "pass-along" control information that is enforced without involvement or advance knowledge of the participants, etc.

The present invention allows content providers and users  
to formulate their transaction environment to accommodate:

- 5                   (1)   desired content models, content control models, and  
                    content usage information pathways,
- (2)   a complete range of electronic media and distribution  
                    means,
- 10               (3)   a broad range of pricing, payment, and auditing  
                    strategies,
- (4)   very flexible privacy and/or reporting models,
- 15               (5)   practical and effective security architectures, and
- (6)   other administrative procedures that together with  
                    steps (1) through (5) can enable most "real world"  
                    electronic commerce and data security models,  
20               including models unique to the electronic world.

VDE's transaction management capabilities can enforce:

- (1) privacy rights of users related to information regarding their usage of electronic information and/or appliances,
- 5 (2) societal policy such as laws that protect rights of content users or require the collection of taxes derived from electronic transaction revenue, and
- (3) the proprietary and/or other rights of parties related  
10 to ownership of, distribution of, and/or other commercial rights related to, electronic information.

VDE can support "real" commerce in an electronic form, that is the progressive creation of commercial relationships that  
15 form, over time, a network of interrelated agreements representing a value chain business model. This is achieved in part by enabling content control information to develop through the interaction of (negotiation between) securely created and independently submitted sets of content and/or appliance control  
20 information. Different sets of content and/or appliance control information can be submitted by different parties in an electronic business value chain enabled by the present invention. These parties create control information sets through the use of their respective VDE installations. Independently, securely  
25 deliverable, component based control information allows efficient

interaction among control information sets supplied by different parties.

5 VDE permits multiple, separate electronic arrangements to be formed between subsets of parties in a VDE supported electronic value chain model. These multiple agreements together comprise a VDE value chain "extended" agreement. VDE allows such constituent electronic agreements, and therefore overall VDE extended agreements, to evolve and  
10 reshape over time as additional VDE participants become involved in VDE content and/or appliance control information handling. VDE electronic agreements may also be extended as new control information is submitted by existing participants. With VDE, electronic commerce participants are free to structure  
15 and restructure their electronic commerce business activities and relationships. As a result, the present invention allows a competitive electronic commerce marketplace to develop since the use of VDE enables different, widely varying business models using the same or shared content.

20

A significant facet of the present invention's ability to broadly support electronic commerce is its ability to securely manage independently delivered VDE component objects containing control information (normally in the form of VDE  
25 objects containing one or more methods, data, or load module

VDE components). This independently delivered control information can be integrated with senior and other pre-existing content control information to securely form derived control information using the negotiation mechanisms of the present invention. All requirements specified by this derived control information must be satisfied before VDE controlled content can be accessed or otherwise used. This means that, for example, all load modules and any mediating data which are listed by the derived control information as required must be available and securely perform their required function. In combination with other aspects of the present invention, securely, independently delivered control components allow electronic commerce participants to freely stipulate their business requirements and trade offs. As a result, much as with traditional, non-electronic commerce, the present invention allows electronic commerce (through a progressive stipulation of various control requirements by VDE participants) to evolve into forms of business that are the most efficient, competitive and useful.

VDE provides capabilities that rationalize the support of electronic commerce and electronic transaction management. This rationalization stems from the reusability of control structures and user interfaces for a wide variety of transaction management related activities. As a result, content usage control, data security, information auditing, and electronic



financial activities, can be supported with tools that are reusable, convenient, consistent, and familiar. In addition, a rational approach—a transaction/distribution control standard—allows all participants in VDE the same foundation set of hardware  
5 control and security, authoring, administration, and management tools to support widely varying types of information, business market model, and/or personal objectives.

Employing VDE as a general purpose electronic  
10 transaction/distribution control system allows users to maintain a single transaction management control arrangement on each of their computers, networks, communication nodes, and/or other electronic appliances. Such a general purpose system can serve the needs of many electronic transaction management  
15 applications without requiring distinct, different installations for different purposes. As a result, users of VDE can avoid the confusion and expense and other inefficiencies of different, limited purpose transaction control applications for each different content and/or business model. For example, VDE allows content  
20 creators to use the same VDE foundation control arrangement for both content authoring and for licensing content from other content creators for inclusion into their products or for other use. Clearinghouses, distributors, content creators, and other VDE users can all interact, both with the applications running on their  
25 VDE installations, and with each other, in an entirely consistent

manner, using and reusing (largely transparently) the same distributed tools, mechanisms, and consistent user interfaces, regardless of the type of VDE activity.

5           VDE prevents many forms of unauthorized use of electronic information, by controlling and auditing (and other administration of use) electronically stored and/or disseminated information. This includes, for example, commercially distributed content, electronic currency, electronic credit,  
10       business transactions (such as EDI), confidential communications, and the like. VDE can further be used to enable commercially provided electronic content to be made available to users in user defined portions, rather than constraining the user to use portions of content that were "predetermined" by a content  
15       creator and/or other provider for billing purposes.

VDE, for example, can employ:

- 20       (1)   Secure metering means for budgeting and/or auditing electronic content and/or appliance usage;
- (2)   Secure flexible means for enabling compensation and/or billing rates for content and/or appliance usage, including electronic credit and/or currency  
25       mechanisms for payment means;

- 5
- (3) Secure distributed database means for storing control and usage related information (and employing validated compartmentalization and tagging schemes);
- (4) Secure electronic appliance control means;
- 10
- (5) A distributed, secure, "virtual black box" comprised of nodes located at every user (including VDE content container creators, other content providers, client users, and recipients of secure VDE content usage information) site. The nodes of said virtual black box normally include a secure subsystem having at least one secure hardware element (a semiconductor element or other hardware module for securely executing VDE control processes), said secure subsystems being distributed at nodes along a pathway of information storage, distribution, payment, usage, and/or auditing. In some
- 15
- 20
- embodiments, the functions of said hardware element, for certain or all nodes, may be performed by software, for example, in host processing environments of electronic appliances;
- 25
- (6) Encryption and decryption means;

- 5 (7) Secure communications means employing authentication, digital signaturing, and encrypted transmissions. The secure subsystems at said user nodes utilize a protocol that establishes and authenticates each node's and/or participant's identity, and establishes one or more secure host-to-host encryption keys for communications between the secure subsystems; and
- 10 (8) Secure control means that can allow each VDE installation to perform VDE content authoring (placing content into VDE containers with associated control information), content distribution, and content usage; as well as clearinghouse and other
- 15 administrative and analysis activities employing content usage information.

VDE may be used to migrate most non-electronic, traditional information delivery models (including entertainment, reference materials, catalog shopping, etc.) into an adequately

20 secure digital distribution and usage management and payment context. The distribution and financial pathways managed by a VDE arrangement may include:

25 ! content creator(s),

- ! distributor(s),
- ! redistributor(s),
- ! client administrator(s),
- ! client user(s),
- 5 ! financial and/or other clearinghouse(s),
- ! and/or government agencies.

These distribution and financial pathways may also include:

- 10 ! advertisers,
- ! market survey organizations, and/or
- ! other parties interested in the user usage of  
information securely delivered and/or stored using  
VDE.

15

Normally, participants in a VDE arrangement will employ the same secure VDE foundation. Alternate embodiments support VDE arrangements employing differing VDE foundations. Such alternate embodiments may employ procedures to ensure certain  
20 interoperability requirements are met.

Secure VDE hardware (also known as SPUs for Secure Processing Units), or VDE installations that use software to substitute for, or complement, said hardware (provided by Host  
25 Processing Environments (HPEs)), operate in conjunction with

secure communications, systems integration software, and distributed software control information and support structures, to achieve the electronic contract/rights protection environment of the present invention. Together, these VDE components  
5 comprise a secure, virtual, distributed content and/or appliance control, auditing (and other administration), reporting, and payment environment. In some embodiments and where commercially acceptable, certain VDE participants, such as clearinghouses that normally maintain sufficiently physically  
10 secure non-VDE processing environments, may be allowed to employ HPEs rather VDE hardware elements and interoperate, for example, with VDE end-users and content providers. VDE components together comprise a configurable, consistent, secure and "trusted" architecture for distributed, asynchronous control  
15 of electronic content and/or appliance usage. VDE supports a "universe wide" environment for electronic content delivery, broad dissemination, usage reporting, and usage related payment activities.

20 VDE provides generalized configurability. This results, in part, from decomposition of generalized requirements for supporting electronic commerce and data security into a broad range of constituent "atomic" and higher level components (such as load modules, data elements, and methods) that may be  
25 variously aggregated together to form control methods for

electronic commerce applications, commercial electronic agreements, and data security arrangements. VDE provides a secure operating environment employing VDE foundation elements along with secure independently deliverable VDE components that enable electronic commerce models and relationships to develop. VDE specifically supports the unfolding of distribution models in which content providers, over time, can expressly agree to, or allow, subsequent content providers and/or users to participate in shaping the control information for, and consequences of, use of electronic content and/or appliances. A very broad range of the functional attributes important for supporting simple to very complex electronic commerce and data security activities are supported by capabilities of the present invention. As a result, VDE supports most types of electronic information and/or appliance: usage control (including distribution), security, usage auditing, reporting, other administration, and payment arrangements.

VDE, in its preferred embodiment, employs object software technology and uses object technology to form "containers" for delivery of information that is (at least in part) encrypted or otherwise secured. These containers may contain electronic content products or other electronic information and some or all of their associated permissions (control) information. These container objects may be distributed along pathways involving

content providers and/or content users. They may be securely moved among nodes of a Virtual Distribution Environment (VDE) arrangement, which nodes operate VDE foundation software and execute control methods to enact electronic information usage control and/or administration models. The containers delivered through use of the preferred embodiment of the present invention may be employed both for distributing VDE control instructions (information) and/or to encapsulate and electronically distribute content that has been at least partially secured.

Content providers who employ the present invention may include, for example, software application and game publishers, database publishers, cable, television, and radio broadcasters, electronic shopping vendors, and distributors of information in electronic document, book, periodical, e-mail and/or other forms. Corporations, government agencies, and/or individual "end-users" who act as storers of, and/or distributors of, electronic information, may also be VDE content providers (in a restricted model, a user provides content only to himself and employs VDE to secure his own confidential information against unauthorized use by other parties). Electronic information may include proprietary and/or confidential information for personal or internal organization use, as well as information, such as software applications, documents, entertainment materials,



and/or reference information, which may be provided to other parties. Distribution may be by, for example, physical media delivery, broadcast and/or telecommunication means, and in the form of "static" files and/or streams of data. VDE may also be used, for example, for multi-site "real-time" interaction such as teleconferencing, interactive games, or on-line bulletin boards, where restrictions on, and/or auditing of, the use of all or portions of communicated information is enforced.

VDE provides important mechanisms for both enforcing commercial agreements and enabling the protection of privacy rights. VDE can securely deliver information from one party to another concerning the use of commercially distributed electronic content. Even if parties are separated by several "steps" in a chain (pathway) of handling for such content usage information, such information is protected by VDE through encryption and/or other secure processing. Because of that protection, the accuracy of such information is guaranteed by VDE, and the information can be trusted by all parties to whom it is delivered.

Furthermore, VDE guarantees that all parties can trust that such information cannot be received by anyone other than the intended, authorized, party(ies) because it is encrypted such that only an authorized party, or her agents, can decrypt it. Such information may also be derived through a secure VDE process at a previous pathway-of-handling location to produce secure VDE

reporting information that is then communicated securely to its intended recipient's VDE secure subsystem. Because VDE can deliver such information securely, parties to an electronic agreement need not trust the accuracy of commercial usage  
5 and/or other information delivered through means other than those under control of VDE.

VDE participants in a commercial value chain can be "commercially" confident (that is, sufficiently confident for  
10 commercial purposes) that the direct (constituent) and/or "extended" electronic agreements they entered into through the use of VDE can be enforced reliably. These agreements may have both "dynamic" transaction management related aspects, such as content usage control information enforced through budgeting,  
15 metering, and/or reporting of electronic information and/or appliance use, and/or they may include "static" electronic assertions, such as an end-user using the system to assert his or her agreement to pay for services, not to pass to unauthorized parties electronic information derived from usage of content or  
20 systems, and/or agreeing to observe copyright laws. Not only can electronically reported transaction related information be trusted under the present invention, but payment may be automated by the passing of payment tokens through a pathway of payment (which may or may not be the same as a pathway for reporting).  
25 Such payment can be contained within a VDE container created

automatically by a VDE installation in response to control information (located, in the preferred embodiment, in one or more permissions records) stipulating the "withdrawal" of credit or electronic currency (such as tokens) from an electronic account  
5 (for example, an account securely maintained by a user's VDE installation secure subsystem) based upon usage of VDE controlled electronic content and/or appliances (such as governments, financial credit providers, and users).

10 VDE allows the needs of electronic commerce participants to be served and it can bind such participants together in a universe wide, trusted commercial network that can be secure enough to support very large amounts of commerce. VDE's security and metering secure subsystem core will be present at  
15 all physical locations where VDE related content is (a) assigned usage related control information (rules and mediating data), and/or (b) used. This core can perform security and auditing functions (including metering) that operate within a "virtual black box," a collection of distributed, very secure VDE related  
20 hardware instances that are interconnected by secured information exchange (for example, telecommunication) processes and distributed database means. VDE further includes highly configurable transaction operating system technology, one or more associated libraries of load modules along with affiliated  
25 data, VDE related administration, data preparation, and analysis

applications, as well as system software designed to enable VDE integration into host environments and applications. VDE's usage control information, for example, provide for property content and/or appliance related: usage authorization, usage auditing (which may include audit reduction), usage billing, usage payment, privacy filtering, reporting, and security related communication and encryption techniques.

VDE extensively employs methods in the form of software objects to augment configurability, portability, and security of the VDE environment. It also employs a software object architecture for VDE content containers that carries protected content and may also carry both freely available information (e.g, summary, table of contents) and secured content control information which ensures the performance of control information. Content control information governs content usage according to criteria set by holders of rights to an object's contents and/or according to parties who otherwise have rights associated with distributing such content (such as governments, financial credit providers, and users).

In part, security is enhanced by object methods employed by the present invention because the encryption schemes used to protect an object can efficiently be further used to protect the associated content control information (software control

information and relevant data) from modification. Said object techniques also enhance portability between various computer and/or other appliance environments because electronic information in the form of content can be inserted along with (for  
5 example, in the same object container as) content control information (for said content) to produce a "published" object. As a result, various portions of said control information may be specifically adapted for different environments, such as for diverse computer platforms and operating systems, and said  
10 various portions may all be carried by a VDE container.

An objective of VDE is supporting a transaction/distribution control standard. Development of such a standard has many obstacles, given the security requirements  
15 and related hardware and communications issues, widely differing environments, information types, types of information usage, business and/or data security goals, varieties of participants, and properties of delivered information. A significant feature of VDE accommodates the many, varying  
20 distribution and other transaction variables by, in part, decomposing electronic commerce and data security functions into generalized capability modules executable within a secure hardware SPU and/or corresponding software subsystem and further allowing extensive flexibility in assembling, modifying,  
25 and/or replacing, such modules (e.g. load modules and/or

methods) in applications run on a VDE installation foundation.  
This configurability and reconfigurability allows electronic  
commerce and data security participants to reflect their priorities  
and requirements through a process of iteratively shaping an  
5 evolving extended electronic agreement (electronic control  
model). This shaping can occur as content control information  
passes from one VDE participant to another and to the extent  
allowed by "in place" content control information. This process  
allows users of VDE to recast existing control information and/or  
10 add new control information as necessary (including the  
elimination of no longer required elements).

VDE supports trusted (sufficiently secure) electronic  
information distribution and usage control models for both  
15 commercial electronic content distribution and data security  
applications. It can be configured to meet the diverse  
requirements of a network of interrelated participants that may  
include content creators, content distributors, client  
administrators, end users, and/or clearinghouses and/or other  
20 content usage information users. These parties may constitute a  
network of participants involved in simple to complex electronic  
content dissemination, usage control, usage reporting, and/or  
usage payment. Disseminated content may include both  
originally provided and VDE generated information (such as  
25 content usage information) and content control information may

persist through both chains (one or more pathways) of content and content control information handling, as well as the direct usage of content. The configurability provided by the present invention is particularly critical for supporting electronic commerce, that is enabling businesses to create relationships and evolve strategies that offer competitive value. Electronic commerce tools that are not inherently configurable and interoperable will ultimately fail to produce products (and services) that meet both basic requirements and evolving needs of most commerce applications.

VDE's fundamental configurability will allow a broad range of competitive electronic commerce business models to flourish. It allows business models to be shaped to maximize revenues sources, end-user product value, and operating efficiencies. VDE can be employed to support multiple, differing models, take advantage of new revenue opportunities, and deliver product configurations most desired by users. Electronic commerce technologies that do not, as the present invention does:

- ! support a broad range of possible, complementary revenue activities,
- ! offer a flexible array of content usage features most desired by customers, and
- ! exploit opportunities for operating efficiencies,

will result in products that are often intrinsically more costly and less appealing and therefore less competitive in the marketplace.

5           Some of the key factors contributing to the configurability intrinsic to the present invention include:

- 10           (a)   integration into the fundamental control environment of a broad range of electronic appliances through portable API and programming language tools that efficiently support merging of control and auditing capabilities in nearly any electronic appliance environment while maintaining overall system security;
- 15           (b)   modular data structures;
- (c)   generic content model;
- 20           (d)   general modularity and independence of foundation architectural components;
- (e)   modular security structures;
- 25           (f)   variable length and multiple branching chains of control; and



(g) independent, modular control structures in the form of executable load modules that can be maintained in one or more libraries, and assembled into control methods and models, and where such model control schemes can "evolve" as control information passes through the VDE installations of participants of a pathway of VDE content control information handling.

10           Because of the breadth of issues resolved by the present invention, it can provide the emerging "electronic highway" with a single transaction/distribution control system that can, for a very broad range of commercial and data security models, ensure against unauthorized use of confidential and/or proprietary  
15           information and commercial electronic transactions. VDE's electronic transaction management mechanisms can enforce the electronic rights and agreements of all parties participating in widely varying business and data security models, and this can be efficiently achieved through a single VDE implementation  
20           within each VDE participant's electronic appliance. VDE supports widely varying business and/or data security models that can involve a broad range of participants at various "levels" of VDE content and/or content control information pathways of handling. Different content control and/or auditing models and  
25           agreements may be available on the same VDE installation.

These models and agreements may control content in relationship to, for example, VDE installations and/or users in general; certain specific users, installations, classes and/or other groupings of installations and/or users; as well as to electronic content generally on a given installation, to specific properties, property portions, classes and/or other groupings of content.

Distribution using VDE may package both the electronic content and control information into the same VDE container, and/or may involve the delivery to an end-user site of different pieces of the same VDE managed property from plural separate remote locations and/or in plural separate VDE content containers and/or employing plural different delivery means. Content control information may be partially or fully delivered separately from its associated content to a user VDE installation in one or more VDE administrative objects. Portions of said control information may be delivered from one or more sources. Control information may also be available for use by access from a user's VDE installation secure sub-system to one or more remote VDE secure sub-systems and/or VDE compatible, certified secure remote locations. VDE control processes such as metering, budgeting, decrypting and/or fingerprinting, may as relates to a certain user content usage activity, be performed in a user's local VDE installation secure subsystem, or said processes may be divided amongst plural secure subsystems which may be

located in the same user VDE installations and/or in a network server and in the user installation. For example, a local VDE installation may perform decryption and save any, or all of, usage metering information related to content and/or electronic appliance usage at such user installation could be performed at the server employing secure (e.g., encrypted) communications between said secure subsystems. Said server location may also be used for near real time, frequent, or more periodic secure receipt of content usage information from said user installation, with, for example, metered information being maintained only temporarily at a local user installation.

Delivery means for VDE managed content may include electronic data storage means such as optical disks for delivering one portion of said information and broadcasting and/or telecommunicating means for other portions of said information. Electronic data storage means may include magnetic media, optical media, combined magneto-optical systems, flash RAM memory, bubble memory, and/or other memory storage means such as huge capacity optical storage systems employing holographic, frequency, and/or polarity data storage techniques. Data storage means may also employ layered disc techniques, such as the use of generally transparent and/or translucent materials that pass light through layers of data carrying discs which themselves are physically packaged together as one

thicker disc. Data carrying locations on such discs may be, at least in part, opaque.

VDE supports a general purpose foundation for secure transaction management, including usage control, auditing, reporting, and/or payment. This general purpose foundation is called "VDE Functions" ("VDEFs"). VDE also supports a collection of "atomic" application elements (e.g., load modules) that can be selectively aggregated together to form various VDEF capabilities called control methods and which serve as VDEF applications and operating system functions. When a host operating environment of an electronic appliance includes VDEF capabilities, it is called a "Rights Operating System" (ROS). VDEF load modules, associated data, and methods form a body of information that for the purposes of the present invention are called "control information." VDEF control information may be specifically associated with one or more pieces of electronic content and/or it may be employed as a general component of the operating system capabilities of a VDE installation.

20

VDEF transaction control elements reflect and enact content specific and/or more generalized administrative (for example, general operating system) control information. VDEF capabilities which can generally take the form of applications (application models) that have more or less configurability which

25

can be shaped by VDE participants, through the use, for example, of VDE templates, to employ specific capabilities, along, for example, with capability parameter data to reflect the elements of one or more express electronic agreements between

5 VDE participants in regards to the use of electronic content such as commercially distributed products. These control capabilities manage the use of, and/or auditing of use of, electronic content, as well as reporting information based upon content use, and any payment for said use. VDEF capabilities may "evolve" to reflect

10 the requirements of one or more successive parties who receive or otherwise contribute to a given set of control information. Frequently, for a VDE application for a given content model (such as distribution of entertainment on CD-ROM, content delivery from an Internet repository, or electronic catalog shopping and

15 advertising, or some combination of the above) participants would be able to securely select from amongst available, alternative control methods and apply related parameter data, wherein such selection of control method and/or submission of data would constitute their "contribution" of control information.

20 Alternatively, or in addition, certain control methods that have been expressly certified as securely interoperable and compatible with said application may be independently submitted by a participant as part of such a contribution. In the most general example, a generally certified load module (certified for a given

25 VDE arrangement and/or content class) may be used with many

or any VDE application that operates in nodes of said arrangement. These parties, to the extent they are allowed, can independently and securely add, delete, and/or otherwise modify the specification of load modules and methods, as well as add,  
5 delete or otherwise modify related information.

Normally the party who creates a VDE content container defines the general nature of the VDEF capabilities that will and/or may apply to certain electronic information. A VDE  
10 content container is an object that contains both content ( for example, commercially distributed electronic information products such as computer software programs, movies, electronic publications or reference materials, etc.) and certain control information related to the use of the object's content. A creating  
15 party may make a VDE container available to other parties. Control information delivered by, and/or otherwise available for use with, VDE content containers comprise (for commercial content distribution purposes) VDEF control capabilities (and any associated parameter data) for electronic content. These  
20 capabilities may constitute one or more "proposed" electronic agreements (and/or agreement functions available for selection and/or use with parameter data) that manage the use and/or the consequences of use of such content and which can enact the terms and conditions of agreements involving multiple parties  
25 and their various rights and obligations.

A VDE electronic agreement may be explicit, through a user interface acceptance by one or more parties, for example by a "junior" party who has received control information from a "senior" party, or it may be a process amongst equal parties who individually assert their agreement. Agreement may also result from an automated electronic process during which terms and conditions are "evaluated" by certain VDE participant control information that assesses whether certain other electronic terms and conditions attached to content and/or submitted by another party are acceptable (do not violate acceptable control information criteria). Such an evaluation process may be quite simple, for example a comparison to ensure compatibility between a portion of, or all senior, control terms and conditions in a table of terms and conditions and the submitted control information of a subsequent participant in a pathway of content control information handling, or it may be a more elaborate process that evaluates the potential outcome of, and/or implements a negotiation process between, two or more sets of control information submitted by two or more parties. VDE also accommodates a semi-automated process during which one or more VDE participants directly, through user interface means, resolve "disagreements" between control information sets by accepting and/or proposing certain control information that may be acceptable to control information representing one or more other parties interests and/or responds to certain user interface

queries for selection of certain alternative choices and/or for certain parameter information, the responses being adopted if acceptable to applicable senior control information.

5           When another party (other than the first applier of rules), perhaps through a negotiation process, accepts, and/or adds to and/or otherwise modifies, "in place" content control information, a VDE agreement between two or more parties related to the use of such electronic content may be created (so long as any  
10           modifications are consistent with senior control information). Acceptance of terms and conditions related to certain electronic content may be direct and express, or it may be implicit as a result of use of content (depending, for example, on legal requirements, previous exposure to such terms and conditions,  
15           and requirements of in place control information).

          VDEF capabilities may be employed, and a VDE agreement may be entered into, by a plurality of parties without the VDEF capabilities being directly associated with the  
20           controlling of certain, specific electronic information. For example, certain one or more VDEF capabilities may be present at a VDE installation, and certain VDE agreements may have been entered into during the registration process for a content distribution application, to be used by such installation for  
25           securely controlling VDE content usage, auditing, reporting



and/or payment. Similarly, a specific VDE participant may enter into a VDE user agreement with a VDE content or electronic appliance provider when the user and/or her appliance register with such provider as a VDE installation and/or user. In such events, VDEF in place control information available to the user VDE installation may require that certain VDEF methods are employed, for example in a certain sequence, in order to be able to use all and/or certain classes, of electronic content and/or VDE applications.

VDE ensures that certain prerequisites necessary for a given transaction to occur are met. This includes the secure execution of any required load modules and the availability of any required, associated data. For example, required load modules and data (e.g. in the form of a method) might specify that sufficient credit from an authorized source must be confirmed as available. It might further require certain one or more load modules execute as processes at an appropriate time to ensure that such credit will be used in order to pay for user use of the content. A certain content provider might, for example, require metering the number of copies made for distribution to employees of a given software program (a portion of the program might be maintained in encrypted form and require the presence of a VDE installation to run). This would require the execution of a metering method for copying of the property each time a copy

was made for another employee. This same provider might also charge fees based on the total number of different properties licensed from them by the user and a metering history of their licensing of properties might be required to maintain this  
5 information.

VDE provides organization, community, and/or universe wide secure environments whose integrity is assured by processes securely controlled in VDE participant user  
10 installations (nodes). VDE installations, in the preferred embodiment, may include both software and tamper resistant hardware semiconductor elements. Such a semiconductor arrangement comprises, at least in part, special purpose circuitry that has been designed to protect against tampering with, or  
15 unauthorized observation of, the information and functions used in performing the VDE's control functions. The special purpose secure circuitry provided by the present invention includes at least one of: a dedicated semiconductor arrangement known as a Secure Processing Unit (SPU) and/or a standard microprocessor,  
20 microcontroller, and/or other processing logic that accommodates the requirements of the present invention and functions as an SPU. VDE's secure hardware may be found incorporated into, for example, a fax/modem chip or chip pack, I/O controller, video display controller, and/or other available digital processing  
25 arrangements. It is anticipated that portions of the present

invention's VDE secure hardware capabilities may ultimately be standard design elements of central processing units (CPUs) for computers and various other electronic devices.

5           Designing VDE capabilities into one or more standard microprocessor, microcontroller and/or other digital processing components may materially reduce VDE related hardware costs by employing the same hardware resources for both the transaction management uses contemplated by the present  
10           invention and for other, host electronic appliance functions. This means that a VDE SPU can employ (share) circuitry elements of a "standard" CPU. For example, if a "standard" processor can operate in protected mode and can execute VDE related instructions as a protected activity, then such an embodiment  
15           may provide sufficient hardware security for a variety of applications and the expense of a special purpose processor might be avoided. Under one preferred embodiment of the present invention, certain memory (e.g., RAM, ROM, NVRAM) is maintained during VDE related instruction processing in a  
20           protected mode (for example, as supported by protected mode microprocessors). This memory is located in the same package as the processing logic (e.g. processor). Desirably, the packaging and memory of such a processor would be designed using security techniques that enhance its resistance to tampering.

25

The degree of overall security of the VDE system is primarily dependent on the degree of tamper resistance and concealment of VDE control process execution and related data storage activities. Employing special purpose semiconductor packaging techniques can significantly contribute to the degree of security. Concealment and tamper-resistance in semiconductor memory (e.g., RAM, ROM, NVRAM) can be achieved, in part, by employing such memory within an SPU package, by encrypting data before it is sent to external memory (such as an external RAM package) and decrypting encrypted data within the CPU/RAM package before it is executed. This process is used for important VDE related data when such data is stored on unprotected media, for example, standard host storage, such as random access memory, mass storage, etc. In that event, a VDE SPU would encrypt data that results from a secure VDE execution before such data was stored in external memory.

#### **Summary of Some Important Features Provided by VDE in Accordance With the Present Invention**

VDE employs a variety of capabilities that serve as a foundation for a general purpose, sufficiently secure distributed electronic commerce solution. VDE enables an electronic commerce marketplace that supports divergent, competitive business partnerships, agreements, and evolving overall business models. For example, VDE includes features that:

“sufficiently” impede unauthorized and/or uncompensated use of electronic information and/or appliances through the use of secure communication, storage, and transaction management technologies.

5 VDE supports a model wide, distributed security implementation which creates a single secure “virtual” transaction processing and information storage environment. VDE enables distributed VDE installations to securely store and communicate

10 information and remotely control the execution processes and the character of use of electronic information at other VDE installations and in a wide variety of ways;

15 ! support low-cost, efficient, and effective security architectures for transaction control, auditing, reporting, and related communications and information storage. VDE may employ tagging related security techniques, the time-ageing of

20 encryption keys, the compartmentalization of both stored control information (including differentially tagging such stored information to ensure against substitution and tampering) and distributed content (to, for many content applications, employ one or

25 more content encryption keys that are unique to the

specific VDE installation and/or user), private key techniques such as triple DES to encrypt content, public key techniques such as RSA to protect communications and to provide the benefits of digital signature and authentication to securely bind together the nodes of a VDE arrangement, secure processing of important transaction management executable code, and a combining of a small amount of highly secure, hardware protected storage space with a much larger "exposed" mass media storage space storing secured (normally encrypted and tagged) control and audit information. VDE employs special purpose hardware distributed throughout some or all locations of a VDE implementation: a) said hardware controlling important elements of: content preparation (such as causing such content to be placed in a VDE content container and associating content control information with said content), content and/or electronic appliance usage auditing, content usage analysis, as well as content usage control; and b) said hardware having been designed to securely handle processing load module control activities, wherein said control processing activities may involve a sequence of required control factors;

! support dynamic user selection of information  
subsets of a VDE electronic information product  
(VDE controlled content). This contrasts with the  
constraints of having to use a few high level  
5 individual, pre-defined content provider information  
increments such as being required to select a whole  
information product or product section in order to  
acquire or otherwise use a portion of such product or  
section. VDE supports metering and usage control  
10 over a variety of increments (including "atomic"  
increments, and combinations of different increment  
types) that are selected ad hoc by a user and  
represent a collection of pre-identified one or more  
increments (such as one or more blocks of a  
15 preidentified nature, e.g., bytes, images, logically  
related blocks) that form a generally arbitrary, but  
logical to a user, content "deliverable." VDE control  
information (including budgeting, pricing and  
metering) can be configured so that it can specifically  
20 apply, as appropriate, to ad hoc selection of different,  
unanticipated variable user selected aggregations of  
information increments and pricing levels can be, at  
least in part, based on quantities and/or nature of  
mixed increment selections (for example, a certain  
25 quantity of certain text could mean associated

images might be discounted by 15%; a greater quantity of text in the "mixed" increment selection might mean the images are discounted 20%). Such user selected aggregated information increments can reflect the actual requirements of a user for information and is more flexible than being limited to a single, or a few, high level, (e.g. product, document, database record) predetermined increments. Such high level increments may include quantities of information not desired by the user and as a result be more costly than the subset of information needed by the user if such a subset was available. In sum, the present invention allows information contained in electronic information products to be supplied according to user specification. Tailoring to user specification allows the present invention to provide the greatest value to users, which in turn will generate the greatest amount of electronic commerce activity. The user, for example, would be able to define an aggregation of content derived from various portions of an available content product, but which, as a deliverable for use by the user, is an entirely unique aggregated increment. The user may, for example, select certain numbers of bytes of information from



various portions of an information product, such as a reference work, and copy them to disc in unencrypted form and be billed based on total number of bytes plus a surcharge on the number of "articles" that provided the bytes. A content provider might reasonably charge less for such a user defined information increment since the user does not require all of the content from all of the articles that contained desired information. This process of defining a user desired information increment may involve artificial intelligence database search tools that contribute to the location of the most relevant portions of information from an information product and cause the automatic display to the user of information describing search criteria hits for user selection or the automatic extraction and delivery of such portions to the user. VDE further supports a wide variety of predefined increment types including:

- ! bytes,
- ! images,
- ! content over time for audio or video, or any other increment that can be identified by content provider data mapping efforts, such as:
- ! sentences,

! paragraphs,  
! articles,  
! database records, and  
! byte offsets representing increments of  
5 logically related information.

VDE supports as many simultaneous predefined increment types  
as may be practical for a given type of content and business  
model.

10 ! securely store at a user's site potentially highly  
detailed information reflective of a user's usage of a  
variety of different content segment types and  
employing both inexpensive "exposed" host mass  
storage for maintaining detailed information in the  
15 form of encrypted data and maintaining summary  
information for security testing in highly secure  
special purpose VDE installation nonvolatile  
memory (if available).

20 ! support trusted chain of handling capabilities for  
pathways of distributed electronic information  
and/or for content usage related information. Such  
chains may extend, for example, from a content  
creator, to a distributor, a redistributor, a client  
25 user, and then may provide a pathway for securely

reporting the same and/or differing usage  
information to one or more auditors, such as to one  
or more independent clearinghouses and then back  
to the content providers, including content creators.

5       The same and/or different pathways employed for  
certain content handling, and related content control  
information and reporting information handling,  
may also be employed as one or more pathways for  
electronic payment handling (payment is  
10       characterized in the present invention as  
administrative content) for electronic content and/or  
appliance usage. These pathways are used for  
conveyance of all or portions of content, and/or  
content related control information. Content  
15       creators and other providers can specify the  
pathways that, partially or fully, must be used to  
disseminate commercially distributed property  
content, content control information, payment  
administrative content, and/or associated usage  
20       reporting information. Control information specified  
by content providers may also specify which specific  
parties must or may (including, for example, a group  
of eligible parties from which a selection may be  
made) handle conveyed information. It may also  
25       specify what transmission means (for example

telecommunication carriers or media types) and  
transmission hubs must or may be used.

! support flexible auditing mechanisms, such as  
5 employing "bitmap meters," that achieve a high  
degree of efficiency of operation and throughput and  
allow, in a practical manner, the retention and ready  
recall of information related to previous usage  
activities and related patterns. This flexibility is  
10 adaptable to a wide variety of billing and security  
control strategies such as:

- P upgrade pricing (e.g. suite purchases),
- P pricing discounts (including quantity  
discounts),
- 15 P billing related time duration variables such as  
discounting new purchases based on the  
timing of past purchases, and
- P security budgets based on quantity of  
different, logically related units of electronic  
20 information used over an interval of time.

Use of bitmap meters (including "regular" and "wide"  
bitmap meters) to record usage and/or purchase of  
information, in conjunction with other elements of  
25 the preferred embodiment of the present invention,

uniquely supports efficient maintenance of usage history for: (a) rental, (b) flat fee licensing or purchase, (c) licensing or purchase discounts based upon historical usage variables, and (d) reporting to users in a manner enabling users to determine whether a certain item was acquired, or acquired within a certain time period (without requiring the use of conventional database mechanisms, which are highly inefficient for these applications). Bitmap meter methods record activities associated with electronic appliances, properties, objects, or portions thereof, and/or administrative activities that are independent of specific properties, objects, etc., performed by a user and/or electronic appliance such that a content and/or appliance provider and/or controller of an administrative activity can determine whether a certain activity has occurred at some point, or during a certain period, in the past (for example, certain use of a commercial electronic content product and/or appliance). Such determinations can then be used as part of pricing and/or control strategies of a content and/or appliance provider, and/or controller of an administrative activity. For example, the content provider may choose to charge only once for access to

a portion of a property, regardless of the number of times that portion of the property is accessed by a user.

5           !       support "launchable" content, that is content that  
can be provided by a content provider to an end-user,  
who can then copy or pass along the content to other  
end-user parties without requiring the direct  
participation of a content provider to register and/or  
10       otherwise initialize the content for use. This content  
goes "out of (the traditional distribution) channel" in  
the form of a "traveling object." Traveling objects are  
containers that securely carry at least some  
permissions information and/or methods that are  
15       required for their use (such methods need not be  
carried by traveling objects if the required methods  
will be available at, or directly available to, a  
destination VDE installation). Certain travelling  
objects may be used at some or all VDE installations  
20       of a given VDE arrangement since they can make  
available the content control information necessary  
for content use without requiring the involvement of  
a commercial VDE value chain participant or data  
security administrator (e.g. a control officer or  
25       network administrator). As long as traveling object

control information requirements are available at the user VDE installation secure subsystem (such as the presence of a sufficient quantity of financial credit from an authorized credit provider), at least  
5 some travelling object content may be used by a receiving party without the need to establish a connection with a remote VDE authority (until, for example, budgets are exhausted or a time content usage reporting interval has occurred). Traveling  
10 objects can travel "out-of-channel," allowing, for example, a user to give a copy of a traveling object whose content is a software program, a movie or a game, to a neighbor, the neighbor being able to use the traveling object if appropriate credit (e.g. an  
15 electronic clearinghouse account from a clearinghouse such as VISA or AT&T) is available. Similarly, electronic information that is generally available on an Internet, or a similar network, repository might be provided in the form of a  
20 traveling object that can be downloaded and subsequently copied by the initial downloader and then passed along to other parties who may pass the object on to additional parties.

! provide very flexible and extensible user  
identification according to individuals, installations,  
by groups such as classes, and by function and  
hierarchical identification employing a hierarchy of  
5 levels of client identification (for example, client  
organization ID, client department ID, client  
network ID, client project ID, and client employee  
ID, or any appropriate subset of the above).

10 ! provide a general purpose, secure, component based  
content control and distribution system that  
functions as a foundation transaction operating  
system environment that employs executable code  
pieces crafted for transaction control and auditing.  
15 These code pieces can be reused to optimize  
efficiency in creation and operation of trusted,  
distributed transaction management arrangements.  
VDE supports providing such executable code in the  
form of "atomic" load modules and associated data.  
20 Many such load modules are inherently configurable,  
aggregatable, portable, and extensible and  
singularly, or in combination (along with associated  
data), run as control methods under the VDE  
transaction operating environment. VDE can satisfy  
25 the requirements of widely differing electronic



commerce and data security applications by, in part,  
employing this general purpose transaction  
management foundation to securely process VDE  
transaction related control methods. Control  
5 methods are created primarily through the use of  
one or more of said executable, reusable load module  
code pieces (normally in the form of executable object  
components) and associated data. The component  
nature of control methods allows the present  
10 invention to efficiently operate as a highly  
configurable content control system. Under the  
present invention, content control models can be  
iteratively and asynchronously shaped, and  
otherwise updated to accommodate the needs of VDE  
15 participants to the extent that such shaping and  
otherwise updating conforms to constraints applied  
by a VDE application, if any (e.g., whether new  
component assemblies are accepted and, if so, what  
certification requirements exist for such component  
20 assemblies or whether any or certain participants  
may shape any or certain control information by  
selection amongst optional control information  
(permissions record) control methods. This iterative  
(or concurrent) multiple participant process occurs  
25 as a result of the submission and use of secure,

control information components (executable code  
such as load modules and/or methods, and/or  
associated data). These components may be  
contributed independently by secure communication  
5 between each control information influencing VDE  
participant's VDE installation and may require  
certification for use with a given application, where  
such certification was provided by a certification  
service manager for the VDE arrangement who  
10 ensures secure interoperability and/or reliability  
(e.g., bug control resulting from interaction) between  
appliances and submitted control methods. The  
transaction management control functions of a VDE  
electronic appliance transaction operating  
15 environment interact with non-secure transaction  
management operating system functions to properly  
direct transaction processes and data related to  
electronic information security, usage control,  
auditing, and usage reporting. VDE provides the  
20 capability to manages resources related to secure  
VDE content and/or appliance control information  
execution and data storage.

! facilitate creation of application and/or system  
25 functionality under VDE and to facilitate integration

into electronic appliance environments of load modules and methods created under the present invention. To achieve this, VDE employs an Application Programmer's Interface (API) and/or a transaction operating system (such as a ROS) programming language with incorporated functions, both of which support the use of capabilities and can be used to efficiently and tightly integrate VDE functionality into commercial and user applications.

support user interaction through: (a) "Pop-Up" applications which, for example, provide messages to users and enable users to take specific actions such as approving a transaction, (b) stand-alone VDE applications that provide administrative environments for user activities such as: end-user preference specifications for limiting the price per transaction, unit of time, and/or session, for accessing history information concerning previous transactions, for reviewing financial information such as budgets, expenditures (e.g. detailed and/or summary) and usage analysis information, and (c) VDE aware applications which, as a result of the use of a VDE API and/or a transaction management (for

example, ROS based) programming language  
embeds VDE "awareness" into commercial or  
internal software (application programs, games, etc.)  
so that VDE user control information and services  
are seamlessly integrated into such software and can  
be directly accessed by a user since the underlying  
functionality has been integrated into the  
commercial software's native design. For example,  
in a VDE aware word processor application, a user  
may be able to "print" a document into a VDE  
content container object, applying specific control  
information by selecting from amongst a series of  
different menu templates for different purposes (for  
example, a confidential memo template for internal  
organization purposes may restrict the ability to  
"keep," that is to make an electronic copy of the  
memo).

! employ "templates" to ease the process of configuring  
capabilities of the present invention as they relate to  
specific industries or businesses. Templates are  
applications or application add-ons under the  
present invention. Templates support the efficient  
specification and/or manipulation of criteria related  
to specific content types, distribution approaches,

pricing mechanisms, user interactions with content  
and/or administrative activities, and/or the like.

Given the very large range of capabilities and  
configurations supported by the present invention,  
5 reducing the range of configuration opportunities to  
a manageable subset particularly appropriate for a  
given business model allows the full configurable  
power of the present invention to be easily employed  
by "typical" users who would be otherwise burdened  
10 with complex programming and/or configuration  
design responsibilities template applications can also  
help ensure that VDE related processes are secure  
and optimally bug free by reducing the risks  
associated with the contribution of independently  
15 developed load modules, including unpredictable  
aspects of code interaction between independent  
modules and applications, as well as security risks  
associated with possible presence of viruses in such  
modules. VDE, through the use of templates,  
20 reduces typical user configuration responsibilities to  
an appropriately focused set of activities including  
selection of method types (e.g. functionality) through  
menu choices such as multiple choice, icon selection,  
and/or prompting for method parameter data (such  
25 as identification information, prices, budget limits,

dates, periods of time, access rights to specific content, etc.) that supply appropriate and/or necessary data for control information purposes. By limiting the typical (non-programming) user to a limited subset of configuration activities whose general configuration environment (template) has been preset to reflect general requirements corresponding to that user, or a content or other business model can very substantially limit difficulties associated with content containerization (including placing initial control information on content), distribution, client administration, electronic agreement implementation, end-user interaction, and clearinghouse activities, including associated interoperability problems (such as conflicts resulting from security, operating system, and/or certification incompatibilities). Use of appropriate VDE templates can assure users that their activities related to content VDE containerization, contribution of other control information, communications, encryption techniques and/or keys, etc. will be in compliance with specifications for their distributed VDE arrangement. VDE templates constitute preset configurations that can normally be reconfigurable

to allow for new and/or modified templates that reflect adaptation into new industries as they evolve or to reflect the evolution or other change of an existing industry. For example, the template concept may be used to provide individual, overall frameworks for organizations and individuals that create, modify, market, distribute, consume, and/or otherwise use movies, audio recordings and live performances, magazines, telephony based retail sales, catalogs, computer software, information data bases, multimedia, commercial communications, advertisements, market surveys, infomercials, games, CAD/CAM services for numerically controlled machines, and the like. As the context surrounding these templates changes or evolves, template applications provided under the present invention may be modified to meet these changes for broad use, or for more focused activities. A given VDE participant may have a plurality of templates available for different tasks. A party that places content in its initial VDE container may have a variety of different, configurable templates depending on the type of content and/or business model related to the content. An end-user may have different configurable templates that can be applied

to different document types (e-mail, secure internal documents, database records, etc.) and/or subsets of users (applying differing general sets of control information to different bodies of users, for example, selecting a list of users who may, under certain preset criteria, use a certain document). Of course, templates may, under certain circumstances have fixed control information and not provide for user selections or parameter data entry.

support plural, different control models regulating the use and/or auditing of either the same specific copy of electronic information content and/or differently regulating different copies (occurrences) of the same electronic information content. Differing models for billing, auditing, and security can be applied to the same piece of electronic information content and such differing sets of control information may employ, for control purposes, the same, or differing, granularities of electronic information control increments. This includes supporting variable control information for budgeting and auditing usage as applied to a variety of predefined increments of electronic information, including employing a variety of different budgets and/or



metering increments for a given electronic  
information deliverable for: billing units of measure,  
credit limit, security budget limit and security  
content metering increments, and/or market  
5 surveying and customer profiling content metering  
increments. For example, a CD-ROM disk with a  
database of scientific articles might be in part billed  
according to a formula based on the number of bytes  
decrypted, number of articles containing said bytes  
10 decrypted, while a security budget might limit the  
use of said database to no more than 5% of the  
database per month for users on the wide area  
network it is installed on.

15 ! provide mechanisms to persistently maintain trusted  
content usage and reporting control information  
through both a sufficiently secure chain of handling  
of content and content control information and  
through various forms of usage of such content  
20 wherein said persistence of control may survive such  
use. Persistence of control includes the ability to  
extract information from a VDE container object by  
creating a new container whose contents are at least  
in part secured and that contains both the extracted  
25 content and at least a portion of the control

information which control information of the original container and/or are at least in part produced by control information of the original container for this purpose and/or VDE installation control information stipulates should persist and/or control usage of content in the newly formed container. Such control information can continue to manage usage of container content if the container is "embedded" into another VDE managed object, such as an object which contains plural embedded VDE containers, each of which contains content derived (extracted) from a different source.

! enables users, other value chain participants (such as clearinghouses and government agencies), and/or user organizations, to specify preferences or requirements related to their use of electronic content and/or appliances. Content users, such as end-user customers using commercially distributed content (games, information resources, software programs, etc.), can define, if allowed by senior control information, budgets, and/or other control information, to manage their own internal use of content. Uses include, for example, a user setting a limit on the price for electronic documents that the

user is willing to pay without prior express user authorization, and the user establishing the character of metering information he or she is willing to allow to be collected (privacy protection).

5 This includes providing the means for content users to protect the privacy of information derived from their use of a VDE installation and content and/or appliance usage auditing. In particular, VDE can prevent information related to a participant's usage  
10 of electronic content from being provided to other parties without the participant's tacit or explicit agreement.

! provide mechanisms that allow control information  
15 to "evolve" and be modified according, at least in part, to independently, securely delivered further control information. Said control information may include executable code (e.g., load modules) that has been certified as acceptable (e.g., reliable and  
20 trusted) for use with a specific VDE application, class of applications, and/or a VDE distributed arrangement. This modification (evolution) of control information can occur upon content control information (load modules and any associated data)  
25 circulating to one or more VDE participants in a

pathway of handling of control information, or it may occur upon control information being received from a VDE participant. Handlers in a pathway of handling of content control information, to the extent each is authorized, can establish, modify, and/or contribute to, permission, auditing, payment, and reporting control information related to controlling, analyzing, paying for, and/or reporting usage of, electronic content and/or appliances (for example, as related to usage of VDE controlled property content). Independently delivered (from an independent source which is independent except in regards to certification), at least in part secure, control information can be employed to securely modify content control information when content control information has flowed from one party to another party in a sequence of VDE content control information handling. This modification employs, for example, one or more VDE component assemblies being securely processed in a VDE secure subsystem. In an alternate embodiment, control information may be modified by a senior party through use of their VDE installation secure sub-system after receiving submitted, at least in part secured, control information from a "junior" party, normally in the

form of a VDE administrative object. Control information passing along VDE pathways can represent a mixed control set, in that it may include: control information that persisted through a sequence of control information handlers, other control information that was allowed to be modified, and further control information representing new control information and/or mediating data. Such a control set represents an evolution of control information for disseminated content. In this example the overall content control set for a VDE content container is "evolving" as it securely (e.g. communicated in encrypted form and using authentication and digital signaturing techniques) passes, at least in part, to a new participant's VDE installation where the proposed control information is securely received and handled. The received control information may be integrated (through use of the receiving parties' VDE installation secure sub-system) with in-place control information through a negotiation process involving both control information sets. For example, the modification, within the secure sub-system of a content provider's VDE installation, of content control information for a certain VDE content container may have occurred as

a result of the incorporation of required control  
information provided by a financial credit provider.  
Said credit provider may have employed their VDE  
installation to prepare and securely communicate  
5 (directly or indirectly) said required control  
information to said content provider. Incorporating  
said required control information enables a content  
provider to allow the credit provider's credit to be  
employed by a content end-user to compensate for  
10 the end-user's use of VDE controlled content and/or  
appliances, so long as said end-user has a credit  
account with said financial credit provider and said  
credit account has sufficient credit available.  
Similarly, control information requiring the payment  
15 of taxes and/or the provision of revenue information  
resulting from electronic commerce activities may be  
securely received by a content provider. This control  
information may be received, for example, from a  
government agency. Content providers might be  
20 required by law to incorporate such control  
information into the control information for  
commercially distributed content and/or services  
related to appliance usage. Proposed control  
information is used to an extent allowed by senior  
25 control information and as determined by any

negotiation trade-offs that satisfy priorities stipulated by each set (the received set and the proposed set). VDE also accommodates different control schemes specifically applying to different participants (e.g., individual participants and/or participant classes (types)) in a network of VDE content handling participants.

! support multiple simultaneous control models for the same content property and/or property portion. This allows, for example, for concurrent business activities which are dependent on electronic commercial product content distribution, such as acquiring detailed market survey information and/or supporting advertising, both of which can increase revenue and result in lower content costs to users and greater value to content providers. Such control information and/or overall control models may be applied, as determined or allowed by control information, in differing manners to different participants in a pathway of content, reporting, payment, and/or related control information handling. VDE supports applying different content control information to the same and/or different content and/or appliance usage related activities,

and/or to different parties in a content and/or  
appliance usage model, such that different parties  
(or classes of VDE users, for example) are subject to  
differing control information managing their use of  
5 electronic information content. For example,  
differing control models based on the category of a  
user as a distributor of a VDE controlled content  
object or an end-user of such content may result in  
different budgets being applied. Alternatively, for  
10 example, a one distributor may have the right to  
distribute a different array of properties than  
another distributor (from a common content  
collection provided, for example, on optical disc). An  
individual, and/or a class or other grouping of  
15 end-users, may have different costs (for example, a  
student, senior citizen, and/or poor citizen user of  
content who may be provided with the same or  
differing discounts) than a "typical" content user.

20 ! support provider revenue information resulting from  
customer use of content and/or appliances, and/or  
provider and/or end-user payment of taxes, through  
the transfer of credit and/or electronic currency from  
said end-user and/or provider to a government  
25 agency, might occur "automatically" as a result of



5 such received control information causing the  
generation of a VDE content container whose  
content includes customer content usage information  
reflecting secure, trusted revenue summary  
information and/or detailed user transaction listings  
(level of detail might depend, for example on type or  
size of transaction—information regarding a bank  
interest payment to a customer or a transfer of a  
large (e.g. over \$10,000) might be, by law,  
10 automatically reported to the government). Such  
summary and/or detailed information related to  
taxable events and/or currency, and/or creditor  
currency transfer, may be passed along a pathway of  
reporting and/or payment to the government in a  
15 VDE container. Such a container may also be used  
for other VDE related content usage reporting  
information.

! support the flowing of content control information  
20 through different “branches” of content control  
information handling so as to accommodate, under  
the present invention’s preferred embodiment,  
diverse controlled distributions of VDE controlled  
content. This allows different parties to employ the  
25 same initial electronic content with differing

(perhaps competitive) control strategies. In this instance, a party who first placed control information on content can make certain control assumptions and these assumptions would evolve into more specific and/or extensive control assumptions. These control assumptions can evolve during the branching sequence upon content model participants submitting control information changes, for example, for use in "negotiating" with "in place" content control information. This can result in new or modified content control information and/or it might involve the selection of certain one or more already "in-place" content usage control methods over in-place alternative methods, as well as the submission of relevant control information parameter data. This form of evolution of different control information sets applied to different copies of the same electronic property content and/or appliance results from VDE control information flowing "down" through different branches in an overall pathway of handling and control and being modified differently as it diverges down these different pathway branches. This ability of the present invention to support multiple pathway branches for the flow of both VDE content control

information and VDE managed content enables an electronic commerce marketplace which supports diverging, competitive business partnerships, agreements, and evolving overall business models which can employ the same content properties combined, for example, in differing collections of content representing differing at least in part competitive products.

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! enable a user to securely extract, through the use of the secure subsystem at the user's VDE installation, at least a portion of the content included within a VDE content container to produce a new, secure object (content container), such that the extracted information is maintained in a continually secure manner through the extraction process. Formation of the new VDE container containing such extracted content shall result in control information consistent with, or specified by, the source VDE content container, and/or local VDE installation secure subsystem as appropriate, content control information. Relevant control information, such as security and administrative information, derived, at least in part, from the parent (source) object's control information, will normally be automatically inserted

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into a new VDE content container object containing  
extracted VDE content. This process typically occurs  
under the control framework of a parent object  
and/or VDE installation control information  
5 executing at the user's VDE installation secure  
subsystem (with, for example, at least a portion of  
this inserted control information being stored  
securely in encrypted form in one or more  
permissions records). In an alternative embodiment,  
10 the derived content control information applied to  
extracted content may be in part or whole derived  
from, or employ, content control information stored  
remotely from the VDE installation that performed  
the secure extraction such as at a remote server  
15 location. As with the content control information for  
most VDE managed content, features of the present  
invention allows the content's control information to:

- (a) "evolve," for example, the extractor of content  
20 may add new control methods and/or modify  
control parameter data, such as VDE  
application compliant methods, to the extent  
allowed by the content's in-place control  
information. Such new control information  
25 might specify, for example, who may use at

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least a portion of the new object, and/or how said at least a portion of said extracted content may be used (e.g. when at least a portion may be used, or what portion or quantity of portions may be used);

10

- (b) allow a user to combine additional content with at least a portion of said extracted content, such as material authored by the extractor and/or content (for example, images, video, audio, and/or text) extracted from one or more other VDE container objects for placement directly into the new container;

15

- (c) allow a user to securely edit at least a portion of said content while maintaining said content in a secure form within said VDE content container;

20

- (d) append extracted content to a pre-existing VDE content container object and attach associated control information -- in these cases, user added information may be secured, e.g., encrypted, in part or as a whole, and may be subject to usage and/or auditing control

25

information that differs from the those applied  
to previously in place object content;

- 5 (e) preserve VDE control over one or more  
portions of extracted content after various  
forms of usage of said portions, for example,  
maintain content in securely stored form while  
allowing "temporary" on screen display of  
content or allowing a software program to be  
10 maintained in secure form but transiently  
decrypt any encrypted executing portion of  
said program (all, or only a portion, of said  
program may be encrypted to secure the  
program).

15  
Generally, the extraction features of the present  
invention allow users to aggregate and/or  
disseminate and/or otherwise use protected  
electronic content information extracted from  
20 content container sources while maintaining secure  
VDE capabilities thus preserving the rights of  
providers in said content information after various  
content usage processes.

! support the aggregation of portions of VDE  
controlled content, such portions being subject to  
differing VDE content container control information,  
wherein various of said portions may have been  
5 provided by independent, different content providers  
from one or more different locations remote to the  
user performing the aggregation. Such aggregation,  
in the preferred embodiment of the present  
invention, may involve preserving at least a portion  
10 of the control information (e.g., executable code such  
as load modules) for each of various of said portions  
by, for example, embedding some or all of such  
portions individually as VDE content container  
objects within an overall VDE content container  
15 and/or embedding some or all of such portions  
directly into a VDE content container. In the latter  
case, content control information of said content  
container may apply differing control information  
sets to various of such portions based upon said  
20 portions original control information requirements  
before aggregation. Each of such embedded VDE  
content containers may have its own control  
information in the form of one or more permissions  
records. Alternatively, a negotiation between control  
25 information associated with various aggregated

portions of electronic content, may produce a control information set that would govern some or all of the aggregated content portions. The VDE content control information produced by the negotiation may  
5 be uniform (such as having the same load modules and/or component assemblies, and/or it may apply differing such content control information to two or more portions that constitute an aggregation of VDE controlled content such as differing metering,  
10 budgeting, billing and/or payment models. For example, content usage payment may be automatically made, either through a clearinghouse, or directly, to different content providers for different portions.

15  
! enable flexible metering of, or other collection of information related to, use of electronic content and/or electronic appliances. A feature of the present invention enables such flexibility of metering  
20 control mechanisms to accommodate a simultaneous, broad array of: (a) different parameters related to electronic information content use; (b) different increment units (bytes, documents, properties, paragraphs, images, etc.) and/or other organizations  
25 of such electronic content; and/or (c) different



categories of user and/or VDE installation types, such as client organizations, departments, projects, networks, and/or individual users, etc. This feature of the present invention can be employed for content security, usage analysis (for example, market surveying), and/or compensation based upon the use and/or exposure to VDE managed content. Such metering is a flexible basis for ensuring payment for content royalties, licensing, purchasing, and/or advertising. A feature of the present invention provides for payment means supporting flexible electronic currency and credit mechanisms, including the ability to securely maintain audit trails reflecting information related to use of such currency or credit. VDE supports multiple differing hierarchies of client organization control information wherein an organization client administrator distributes control information specifying the usage rights of departments, users, and/or projects. Likewise, a department (division) network manager can function as a distributor (budgets, access rights, etc.) for department networks, projects, and/or users, etc.

! provide scalable, integratable, standardized control means for use on electronic appliances ranging from inexpensive consumer (for example, television set-top appliances) and professional devices (and  
5 hand-held PDAs) to servers, mainframes, communication switches, etc. The scalable transaction management/auditing technology of the present invention will result in more efficient and reliable interoperability amongst devices functioning  
10 in electronic commerce and/or data security environments. As standardized physical containers have become essential to the shipping of physical goods around the world, allowing these physical containers to universally "fit" unloading equipment,  
15 efficiently use truck and train space, and accommodate known arrays of objects (for example, boxes) in an efficient manner, so VDE electronic content containers may, as provided by the present invention, be able to efficiently move electronic  
20 information content (such as commercially published properties, electronic currency and credit, and content audit information), and associated content control information, around the world. Interoperability is fundamental to efficient electronic  
25 commerce. The design of the VDE foundation, VDE

load modules, and VDE containers, are important features that enable the VDE node operating environment to be compatible with a very broad range of electronic appliances. The ability, for example, for control methods based on load modules to execute in very "small" and inexpensive secure sub-system environments, such as environments with very little read/write memory, while also being able to execute in large memory sub-systems that may be used in more expensive electronic appliances, supports consistency across many machines. This consistent VDE operating environment, including its control structures and container architecture, enables the use of standardized VDE content containers across a broad range of device types and host operating environments. Since VDE capabilities can be seamlessly integrated as extensions, additions, and/or modifications to fundamental capabilities of electronic appliances and host operating systems, VDE containers, content control information, and the VDE foundation will be able to work with many device types and these device types will be able to consistently and efficiently interpret and enforce VDE control information. Through this integration users can also

benefit from a transparent interaction with many of the capabilities of VDE. VDE integration with software operating on a host electronic appliance supports a variety of capabilities that would be  
5 unavailable or less secure without such integration. Through integration with one or more device applications and/or device operating environments, many capabilities of the present invention can be presented as inherent capabilities of a given  
10 electronic appliance, operating system, or appliance application. For example, features of the present invention include: (a) VDE system software to in part extend and/or modify host operating systems such that they possesses VDE capabilities, such as  
15 enabling secure transaction processing and electronic information storage; (b) one or more application programs that in part represent tools associated with VDE operation; and/or (c) code to be integrated into application programs, wherein such  
20 code incorporates references into VDE system software to integrate VDE capabilities and makes such applications VDE aware (for example, word processors, database retrieval applications, spreadsheets, multimedia presentation authoring  
25 tools, film editing software, music editing software

such as MIDI applications and the like, robotics control systems such as those associated with CAD/CAM environments and NCM software and the like, electronic mail systems, teleconferencing software, and other data authoring, creating, handling, and/or usage applications including combinations of the above). These one or more features (which may also be implemented in firmware or hardware) may be employed in conjunction with a VDE node secure hardware processing capability, such as a microcontroller(s), microprocessor(s), other CPU(s) or other digital processing logic.

! employ audit reconciliation and usage pattern evaluation processes that assess, through certain, normally network based, transaction processing reconciliation and threshold checking activities, whether certain violations of security of a VDE arrangement have occurred. These processes are performed remote to VDE controlled content end-user VDE locations by assessing, for example, purchases, and/or requests, for electronic properties by a given VDE installation. Applications for such reconciliation activities include assessing whether

the quantity of remotely delivered VDE controlled content corresponds to the amount of financial credit and/or electronic currency employed for the use of such content. A trusted organization can acquire information from content providers concerning the cost for content provided to a given VDE installation and/or user and compare this cost for content with the credit and/or electronic currency disbursements for that installation and/or user. Inconsistencies in the amount of content delivered versus the amount of disbursement can prove, and/or indicate, depending on the circumstances, whether the local VDE installation has been, at least to some degree, compromised (for example, certain important system security functions, such as breaking encryption for at least some portion of the secure subsystem and/or VDE controlled content by uncovering one or more keys). Determining whether irregular patterns (e.g. unusually high demand) of content usage, or requests for delivery of certain kinds of VDE controlled information during a certain time period by one or more VDE installations and/or users (including, for example, groups of related users whose aggregate pattern of usage is suspicious) may also be useful in determining whether security at

such one or more installations, and/or by such one or more users, has been compromised, particularly when used in combination with an assessment of electronic credit and/or currency provided to one or more VDE users and/or installations, by some or all of their credit and/or currency suppliers, compared with the disbursements made by such users and/or installations.

10           !     support security techniques that materially increase the time required to "break" a system's integrity. This includes using a collection of techniques that minimizes the damage resulting from comprising some aspect of the security features of the present inventions.

15                               !     provide a family of authoring, administrative, reporting, payment, and billing tool user applications that comprise components of the present invention's trusted/secure, universe wide, distributed transaction control and administration system. These components support VDE related: object creation (including placing control information on content), secure object distribution and management (including distribution control information, financial

20

25

related, and other usage analysis), client internal VDE activities administration and control, security management, user interfaces, payment disbursement, and clearinghouse related functions.

5        These components are designed to support highly secure, uniform, consistent, and standardized: electronic commerce and/or data security pathway(s) of handling, reporting, and/or payment; content control and administration; and human factors (e.g.

10        user interfaces).

!        support the operation of a plurality of clearinghouses, including, for example, both financial and user clearinghouse activities, such as

15        those performed by a client administrator in a large organization to assist in the organization's use of a VDE arrangement, including usage information analysis, and control of VDE activities by individuals and groups of employees such as specifying budgets

20        and the character of usage rights available under VDE for certain groups of and/or individual, client personnel, subject to control information series to control information submitted by the client administrator. At a clearinghouse, one or more VDE

25        installations may operate together with a trusted



distributed database environment (which may include concurrent database processing means). A financial clearinghouse normally receives at its location securely delivered content usage information, and user requests (such as requests for further credit, electronic currency, and/or higher credit limit). Reporting of usage information and user requests can be used for supporting electronic currency, billing, payment and credit related activities, and/or for user profile analysis and/or broader market survey analysis and marketing (consolidated) list generation or other information derived, at least in part, from said usage information. this information can be provided to content providers or other parties, through secure, authenticated encrypted communication to the VDE installation secure subsystems. Clearinghouse processing means would normally be connected to specialized I/O means, which may include high speed telecommunication switching means that may be used for secure communications between a clearinghouse and other VDE pathway participants.

securely support electronic currency and credit usage control, storage, and communication at, and

between, VDE installations. VDE further supports automated passing of electronic currency and/or credit information, including payment tokens (such as in the form of electronic currency or credit) or other payment information, through a pathway of payment, which said pathway may or may not be the same as a pathway for content usage information reporting. Such payment may be placed into a VDE container created automatically by a VDE installation in response to control information stipulating the "withdrawal" of credit or electronic currency from an electronic credit or currency account based upon an amount owed resulting from usage of VDE controlled electronic content and/or appliances. Payment credit or currency may then be automatically communicated in protected (at least in part encrypted) form through telecommunication of a VDE container to an appropriate party such as a clearinghouse, provider of original property content or appliance, or an agent for such provider (other than a clearinghouse). Payment information may be packaged in said VDE content container with, or without, related content usage information, such as metering information. An aspect of the present invention further enables certain information

regarding currency use to be specified as unavailable  
to certain, some, or all VDE parties ("conditionally"  
to fully anonymous currency) and/or further can  
regulate certain content information, such as  
5 currency and/or credit use related information  
(and/or other electronic information usage data) to be  
available only under certain strict circumstances,  
such as a court order (which may itself require  
authorization through the use of a court controlled  
10 VDE installation that may be required to securely  
access "conditionally" anonymous information).  
Currency and credit information, under the  
preferred embodiment of the present invention, is  
treated as administrative content;

15  
! support fingerprinting (also known as  
watermarking) for embedding in content such that  
when content protected under the present invention  
is released in clear form from a VDE object  
20 (displayed, printed, communicated, extracted, and/or  
saved), information representing the identification of  
the user and/or VDE installation responsible for  
transforming the content into clear form is  
embedded into the released content. Fingerprinting  
25 is useful in providing an ability to identify who

5 extracted information in clear form a VDE container,  
or who made a copy of a VDE object or a portion of  
its contents. Since the identity of the user and/or  
other identifying information may be embedded in  
an obscure or generally concealed manner, in VDE  
container content and/or control information,  
potential copyright violators may be deterred from  
unauthorized extraction or copying. Fingerprinting  
normally is embedded into unencrypted electronic  
content or control information, though it can be  
embedded into encrypted content and later placed in  
unencrypted content in a secure VDE installation  
sub-system as the encrypted content carrying the  
fingerprinting information is decrypted. Electronic  
information, such as the content of a VDE container,  
may be fingerprinted as it leaves a network (such as  
Internet) location bound for a receiving party. Such  
repository information may be maintained in  
unencrypted form prior to communication and be  
encrypted as it leaves the repository. Fingerprinting  
would preferably take place as the content leaves the  
repository, but before the encryption step.  
Encrypted repository content can be decrypted, for  
example in a secure VDE sub-system, fingerprint  
information can be inserted, and then the content

can be re-encrypted for transmission. Embedding identification information of the intended recipient user and/or VDE installation into content as it leaves, for example, an Internet repository, would provide important information that would identify or assist in identifying any party that managed to compromise the security of a VDE installation or the delivered content. If a party produces an authorized clear form copy of VDE controlled content, including making unauthorized copies of an authorized clear form copy, fingerprint information would point back to that individual and/or his or her VDE installation. Such hidden information will act as a strong disincentive that should dissuade a substantial portion of potential content "pirates" from stealing other parties electronic information. Fingerprint information identifying a receiving party and/or VDE installation can be embedded into a VDE object before, or during, decryption, replication, or communication of VDE content objects to receivers. Fingerprinting electronic content before it is encrypted for transfer to a customer or other user provides information that can be very useful for identifying who received certain content which may have then been distributed or made available in

unencrypted form. This information would be useful in tracking who may have "broken" the security of a VDE installation and was illegally making certain electronic content available to others.

5           Fingerprinting may provide additional, available information such as time and/or date of the release (for example extraction) of said content information. Locations for inserting fingerprints may be specified by VDE installation and/or content container control  
10           information. This information may specify that certain areas and/or precise locations within properties should be used for fingerprinting, such as one or more certain fields of information or information types. Fingerprinting information may  
15           be incorporated into a property by modifying in a normally undetectable way color frequency and/or the brightness of certain image pixels, by slightly modifying certain audio signals as to frequency, by modifying font character formation, etc. Fingerprint  
20           information, itself, should be encrypted so as to make it particularly difficult for tampered fingerprints to be interpreted as valid. Variations in fingerprint locations for different copies of the same property; "false" fingerprint information; and  
25           multiple copies of fingerprint information within a

specific property or other content which copies  
employ different fingerprinting techniques such as  
information distribution patterns, frequency and/or  
brightness manipulation, and encryption related  
5 techniques, are features of the present invention for  
increasing the difficulty of an unauthorized  
individual identifying fingerprint locations and  
erasing and/or modifying fingerprint information.

10 provide smart object agents that can carry requests,  
data, and/or methods, including budgets,  
authorizations, credit or currency, and content. For  
example, smart objects may travel to and/or from  
remote information resource locations and fulfill  
15 requests for electronic information content. Smart  
objects can, for example, be transmitted to a remote  
location to perform a specified database search on  
behalf of a user or otherwise "intelligently" search  
remote one or more repositories of information for  
20 user desired information. After identifying desired  
information at one or more remote locations, by for  
example, performing one or more database searches,  
a smart object may return via communication to the  
user in the form of a secure "return object"  
25 containing retrieved information. A user may be

charged for the remote retrieving of information, the  
returning of information to the user's VDE  
installation, and/or the use of such information. In  
the latter case, a user may be charged only for the  
5 information in the return object that the user  
actually uses. Smart objects may have the means to  
request use of one or more services and/or resources.  
Services include locating other services and/or  
resources such as information resources, language or  
10 format translation, processing, credit (or additional  
credit) authorization, etc. Resources include  
reference databases, networks, high powered or  
specialized computing resources (the smart object  
may carry information to another computer to be  
15 efficiently processed and then return the information  
to the sending VDE installation), remote object  
repositories, etc. Smart objects can make efficient  
use of remote resources (e.g. centralized databases,  
super computers, etc.) while providing a secure  
20 means for charging users based on information  
and/or resources actually used.

! support both "translations" of VDE electronic  
agreements elements into modern language printed  
25 agreement elements (such as English language



agreements) and translations of electronic rights  
protection/transaction management modern  
language agreement elements to electronic VDE  
agreement elements. This feature requires  
5 maintaining a library of textual language that  
corresponds to VDE load modules and/or methods  
and/or component assemblies. As VDE methods are  
proposed and/or employed for VDE agreements, a  
listing of textual terms and conditions can be  
10 produced by a VDE user application which, in a  
preferred embodiment, provides phrases, sentences  
and/or paragraphs that have been stored and  
correspond to said methods and/or assemblies. This  
feature preferably employs artificial intelligence  
15 capabilities to analyze and automatically determine,  
and/or assist one or more users to determine, the  
proper order and relationship between the library  
elements corresponding to the chosen methods  
and/or assemblies so as to compose some or all  
20 portions of a legal or descriptive document. One or  
more users, and/or preferably an attorney (if the  
document a legal, binding agreement), would review  
the generated document material upon completion  
and employ such additional textual information  
25 and/or editing as necessary to describe non electronic

transaction elements of the agreement and make  
any other improvements that may be necessary.  
These features further support employing modern  
language tools that allow one or more users to make  
5 selections from choices and provide answers to  
questions and to produce a VDE electronic  
agreement from such a process. This process can be  
interactive and the VDE agreement formulation  
process may employ artificial intelligence expert  
10 system technology that learns from responses and,  
where appropriate and based at least in part on said  
responses, provides further choices and/or questions  
which "evolves" the desired VDE electronic  
agreement.

15

! support the use of multiple VDE secure subsystems  
in a single VDE installation. Various security and/or  
performance advantages may be realized by  
employing a distributed VDE design within a single  
20 VDE installation. For example, designing a  
hardware based VDE secure subsystem into an  
electronic appliance VDE display device, and  
designing said subsystem's integration with said  
display device so that it is as close as possible to the  
25 point of display, will increase the security for video

materials by making it materially more difficult to  
“steal” decrypted video information as it moves from  
outside to inside the video system. Ideally, for  
example, a VDE secure hardware module would be  
5 in the same physical package as the actual display  
monitor, such as within the packaging of a video  
monitor or other display device, and such device  
would be designed, to the extent commercially  
practical, to be as tamper resistant as reasonable.  
10 As another example, embedding a VDE hardware  
module into an I/O peripheral may have certain  
advantages from the standpoint of overall system  
throughput. If multiple VDE instances are employed  
within the same VDE installation, these instances  
15 will ideally share resources to the extent practical,  
such as VDE instances storing certain control  
information and content and/or appliance usage  
information on the same mass storage device and in  
the same VDE management database.  
20  
! requiring reporting and payment compliance by  
employing exhaustion of budgets and time ageing of  
keys. For example, a VDE commercial arrangement  
and associated content control information may  
25 involve a content provider’s content and the use of

clearinghouse credit for payment for end-user usage  
of said content. Control information regarding said  
arrangement may be delivered to a user's (of said  
content) VDE installation and/or said financial  
clearinghouse's VDE installation. Said control  
information might require said clearinghouse to  
prepare and telecommunicate to said content  
provider both content usage based information in a  
certain form, and content usage payment in the form  
of electronic credit (such credit might be "owned" by  
the provider after receipt and used in lieu of the  
availability or adequacy of electronic currency)  
and/or electronic currency. This delivery of  
information and payment may employ trusted VDE  
installation secure subsystems to securely, and in  
some embodiments, automatically, provide in the  
manner specified by said control information, said  
usage information and payment content. Features of  
the present invention help ensure that a  
requirement that a clearinghouse report such usage  
information and payment content will be observed.  
For example, if one participant to a VDE electronic  
agreement fails to observe such information  
reporting and/or paying obligation, another  
participant can stop the delinquent party from

successfully participating in VDE activities related to such agreement. For example, if required usage information and payment was not reported as specified by content control information, the

5 "injured" party can fail to provide, through failing to securely communicate from his VDE installation secure subsystem, one or more pieces of secure information necessary for the continuance of one or more critical processes. For example, failure to

10 report information and/or payment from a clearinghouse to a content provider (as well as any security failures or other disturbing irregularities) can result in the content provider not providing key and/or budget refresh information to the

15 clearinghouse, which information can be necessary to authorize use of the clearinghouse's credit for usage of the provider's content and which the clearinghouse would communicate to end-user's during a content usage reporting communication

20 between the clearinghouse and end-user. As another example, a distributor that failed to make payments and/or report usage information to a content provider might find that their budget for creating permissions records to distribute the content

25 provider's content to users, and/or a security budget

limiting one or more other aspect of their use of the provider's content, are not being refreshed by the content provider, once exhausted or timed-out (for example, at a predetermined date). In these and  
5 other cases, the offended party might decide not to refresh time ageing keys that had "aged out." Such a use of time aged keys has a similar impact as failing to refresh budgets or time-aged authorizations.

10 support smart card implementations of the present invention in the form of portable electronic appliances, including cards that can be employed as secure credit, banking, and/or money cards. A feature of the present invention is the use of portable  
15 VDEs as transaction cards at retail and other establishments, wherein such cards can "dock" with an establishment terminal that has a VDE secure sub-system and/or an online connection to a VDE secure and/or otherwise secure and compatible  
20 subsystem, such as a "trusted" financial clearinghouse (e.g., VISA, Mastercard). The VDE card and the terminal (and/or online connection) can securely exchange information related to a transaction, with credit and/or electronic currency  
25 being transferred to a merchant and/or

clearinghouse and transaction information flowing  
back to the card. Such a card can be used for  
transaction activities of all sorts. A docking station,  
such as a PCMCIA connector on an electronic  
5 appliance, such as a personal computer, can receive  
a consumer's VDE card at home. Such a station/card  
combination can be used for on-line transactions in  
the same manner as a VDE installation that is  
permanently installed in such an electronic  
10 appliance. The card can be used as an "electronic  
wallet" and contain electronic currency as well as  
credit provided by a clearinghouse. The card can act  
as a convergence point for financial activities of a  
consumer regarding many, if not all, merchant,  
15 banking, and on-line financial transactions,  
including supporting home banking activities. A  
consumer can receive his paycheck and/or  
investment earnings and/or "authentic" VDE content  
container secured detailed information on such  
20 receipts, through on-line connections. A user can  
send digital currency to another party with a VDE  
arrangement, including giving away such currency.  
A VDE card can retain details of transactions in a  
highly secure and database organized fashion so that  
25 financially related information is both consolidated

and very easily retrieved and/or analyzed. Because of the VDE security, including use of effective encryption, authentication, digital signaturing, and secure database structures, the records contained within a VDE card arrangement may be accepted as valid transaction records for government and/or corporate recordkeeping requirements. In some embodiments of the present invention a VDE card may employ docking station and/or electronic appliance storage means and/or share other VDE arrangement means local to said appliance and/or available across a network, to augment the information storage capacity of the VDE card, by for example, storing dated, and/or archived, backup information. Taxes relating to some or all of an individual's financial activities may be automatically computed based on "authentic" information securely stored and available to said VDE card. Said information may be stored in said card, in said docking station, in an associated electronic appliance, and/or other device operatively attached thereto, and/or remotely, such as at a remote server site. A card's data, e.g. transaction history, can be backed up to an individual's personal computer or other electronic appliance and such an appliance



may have an integrated VDE installation of its own.

A current transaction, recent transactions (for redundancy), or all or other selected card data may be backed up to a remote backup repository, such a VDE compatible repository at a financial clearinghouse, during each or periodic docking for a financial transaction and/or information communication such as a user/merchant transaction. Backing up at least the current transaction during a connection with another party's VDE installation (for example a VDE installation that is also on a financial or general purpose electronic network), by posting transaction information to a remote clearinghouse and/or bank, can ensure that sufficient backup is conducted to enable complete reconstruction of VDE card internal information in the event of a card failure or loss.

! support certification processes that ensure authorized interoperability between various VDE installations so as to prevent VDE arrangements and/or installations that unacceptably deviate in specification protocols from other VDE arrangements and/or installations from interoperating in a manner that may introduce security (integrity and/or

confidentiality of VDE secured information), process control, and/or software compatibility problems.

Certification validates the identity of VDE installations and/or their components, as well as VDE users. Certification data can also serve as information that contributes to determining the decommissioning or other change related to VDE sites.

! support the separation of fundamental transaction control processes through the use of event (triggered) based method control mechanisms. These event methods trigger one or more other VDE methods (which are available to a secure VDE sub-system) and are used to carry out VDE managed transaction related processing. These triggered methods include independently (separably) and securely processable component billing management methods, budgeting management methods, metering management methods, and related auditing management processes. As a result of this feature of the present invention, independent triggering of metering, auditing, billing, and budgeting methods, the present invention is able to efficiently, concurrently support multiple financial currencies (e.g. dollars,

marks, yen) and content related budgets, and/or  
billing increments as well as very flexible content  
distribution models.

5                   !       support, complete, modular separation of the control  
structures related to (1) content event triggering, (2)  
auditing, (3) budgeting (including specifying no right  
of use or unlimited right of use), (4) billing, and (5)  
user identity (VDE installation, client name,  
10       department, network, and/or user, etc.). The  
independence of these VDE control structures  
provides a flexible system which allows plural  
relationships between two or more of these  
structures, for example, the ability to associate a  
15       financial budget with different event trigger  
structures (that are put in place to enable controlling  
content based on its logical portions). Without such  
separation between these basic VDE capabilities, it  
would be more difficult to efficiently maintain  
20       separate metering, budgeting, identification, and/or  
billing activities which involve the same, differing  
(including overlapping), or entirely different,  
portions of content for metering, billing, budgeting,  
and user identification, for example, paying fees  
25       associated with usage of content, performing home

banking, managing advertising services, etc. VDE modular separation of these basic capabilities supports the programming of plural, "arbitrary" relationships between one or differing content portions (and/or portion units) and budgeting, auditing, and/or billing control information. For example, under VDE, a budget limit of \$200 dollars or 300 German Marks a month may be enforced for decryption of a certain database and 2 U.S. Dollars or 3 German Marks may be charged for each record of said database decrypted (depending on user selected currency). Such usage can be metered while an additional audit for user profile purposes can be prepared recording the identity of each filed displayed. Additionally, further metering can be conducted regarding the number of said database bytes that have been decrypted, and a related security budget may prevent the decrypting of more than 5% of the total bytes of said database per year. The user may also, under VDE (if allowed by senior control information), collect audit information reflecting usage of database fields by different individuals and client organization departments and ensure that differing rights of access and differing budgets limiting database usage can be applied to

these client individuals and groups. Enabling  
content providers and users to practically employ  
such diverse sets of user identification, metering,  
budgeting, and billing control information results, in  
part, from the use of such independent control  
capabilities. As a result, VDE can support great  
configurability in creation of plural control models  
applied to the same electronic property and the same  
and/or plural control models applied to differing or  
entirely different content models (for example, home  
banking versus electronic shopping).

#### **Methods, Other Control Information, and VDE Objects**

VDE control information (e.g., methods) that collectively  
control use of VDE managed properties (database, document,  
individual commercial product), are either shipped with the  
content itself (for example, in a content container) and/or one or  
more portions of such control information is shipped to  
distributors and/or other users in separably deliverable  
“administrative objects.” A subset of the methods for a property  
may in part be delivered with each property while one or more  
other subsets of methods can be delivered separately to a user or  
otherwise made available for use (such as being available  
remotely by telecommunication means). Required methods  
(methods listed as required for property and/or appliance use)

must be available as specified if VDE controlled content (such as intellectual property distributed within a VDE content container) is to be used. Methods that control content may apply to a plurality of VDE container objects, such as a class or other grouping of such objects. Methods may also be required by certain users or classes of users and/or VDE installations and/or classes of installations for such parties to use one or more specific, or classes of, objects.

10           A feature of VDE provided by the present invention is that certain one or more methods can be specified as required in order for a VDE installation and/or user to be able to use certain and/or all content. For example, a distributor of a certain type of content might be allowed by "senior" participants (by content creators, for example) to require a method which prohibits end-users from electronically saving decrypted content, a provider of credit for VDE transactions might require an audit method that records the time of an electronic purchase, and/or a user might require a method that summarizes usage information for reporting to a clearinghouse (e.g. billing information) in a way that does not convey confidential, personal information regarding detailed usage behavior.

25           A further feature of VDE provided by the present invention is that creators, distributors, and users of content can select from

among a set of predefined methods (if available) to control container content usage and distribution functions and/or they may have the right to provide new customized methods to control at least certain usage functions (such "new" methods may be required to be certified for trustedness and interoperability to the VDE installation and/or for of a group of VDE applications). As a result, VDE provides a very high degree of configurability with respect to how the distribution and other usage of each property or object (or one or more portions of objects or properties as desired and/or applicable) will be controlled. Each VDE participant in a VDE pathway of content control information may set methods for some or all of the content in a VDE container, so long as such control information does not conflict with senior control information already in place with respect to:

- (1) certain or all VDE managed content,
- (2) certain one or more VDE users and/or groupings of users,
- (3) certain one or more VDE nodes and/or groupings of nodes, and/or
- (4) certain one or more VDE applications and/or arrangements.

For example, a content creator's VDE control information for certain content can take precedence over other submitted VDE participant control information and, for example, if allowed by senior control information, a content distributor's control information may itself take precedence over a client administrator's control information, which may take precedence over an end-user's control information. A path of distribution participant's ability to set such electronic content control information can be limited to certain control information (for example, method mediating data such as pricing and/or sales dates) or it may be limited only to the extent that one or more of the participant's proposed control information conflicts with control information set by senior control information submitted previously by participants in a chain of handling of the property, or managed in said participant's VDE secure subsystem.

VDE control information may, in part or in full, (a) represent control information directly put in place by VDE content control information pathway participants, and/or (b) comprise control information put in place by such a participant on behalf of a party who does not directly handle electronic content (or electronic appliance) permissions records information (for example control information inserted by a participant on behalf of a financial clearinghouse or government agency). Such control information methods (and/or load modules and/or



mediating data and/or component assemblies) may also be put in place by either an electronic automated, or a semi-automated and human assisted, control information (control set) negotiating process that assesses whether the use of one or more pieces of submitted control information will be integrated into and/or replace existing control information (and/or chooses between alternative control information based upon interaction with in-place control information) and how such control information may be used.

10

Control information may be provided by a party who does not directly participate in the handling of electronic content (and/or appliance) and/or control information for such content (and/or appliance). Such control information may be provided in secure form using VDE installation secure sub-system managed communications (including, for example, authenticating the deliverer of at least in part encrypted control information) between such not directly participating one or more parties' VDE installation secure subsystems, and a pathway of VDE content control information participant's VDE installation secure subsystem. This control information may relate to, for example, the right to access credit supplied by a financial services provider, the enforcement of regulations or laws enacted by a government agency, or the requirements of a customer of VDE managed content usage information (reflecting usage of content

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by one or more parties other than such customer) relating to the  
creation, handling and/or manner of reporting of usage  
information received by such customer. Such control information  
may, for example, enforce societal requirements such as laws  
5 related to electronic commerce.

VDE content control information may apply differently to  
different pathway of content and/or control information handling  
participants. Furthermore, permissions records rights may be  
10 added, altered, and/or removed by a VDE participant if they are  
allowed to take such action. Rights of VDE participants may be  
defined in relation to specific parties and/or categories of parties  
and/or other groups of parties in a chain of handling of content  
and/or content control information (e.g., permissions records).  
15 Modifications to control information that may be made by a  
given, eligible party or parties, may be limited in the number of  
modifications, and/or degree of modification, they may make.

At least one secure subsystem in electronic appliances of  
20 creators, distributors, auditors, clearinghouses, client  
administrators, and end-users (understanding that two or more  
of the above classifications may describe a single user) provides a  
"sufficiently" secure (for the intended applications) environment  
for:

25

1. Decrypting properties and control information;
2. Storing control and metering related information;
- 5 3. Managing communications;
4. Processing core control programs, along with  
associated data, that constitute control information  
for electronic content and/or appliance rights  
10 protection, including the enforcing of preferences  
and requirements of VDE participants.

Normally, most usage, audit, reporting, payment, and  
distribution control methods are themselves at least in part  
15 encrypted and are executed by the secure subsystem of a VDE  
installation. Thus, for example, billing and metering records can  
be securely generated and updated, and encryption and  
decryption keys are securely utilized, within a secure subsystem.  
Since VDE also employs secure (e.g. encrypted and  
20 authenticated) communications when passing information  
between the participant location (nodes) secure subsystems of a  
VDE arrangement, important components of a VDE electronic  
agreement can be reliably enforced with sufficient security  
(sufficiently trusted) for the intended commercial purposes. A  
25 VDE electronic agreement for a value chain can be composed, at

least in part, of one or more subagreements between one or more subsets of the value chain participants. These subagreements are comprised of one or more electronic contract "compliance" elements (methods including associated parameter data) that  
5 ensure the protection of the rights of VDE participants.

The degree of trustedness of a VDE arrangement will be primarily based on whether hardware SPUs are employed at participant location secure subsystems and the effectiveness of  
10 the SPU hardware security architecture, software security techniques when an SPU is emulated in software, and the encryption algorithm(s) and keys that are employed for securing content, control information, communications, and access to VDE node (VDE installation) secure subsystems. Physical facility and  
15 user identity authentication security procedures may be used instead of hardware SPUs at certain nodes, such as at an established financial clearinghouse, where such procedures may provide sufficient security for trusted interoperability with a VDE arrangement employing hardware SPUs at user nodes.

20

The updating of property management files at each location of a VDE arrangement, to accommodate new or modified control information, is performed in the VDE secure subsystem and under the control of secure management file updating  
25 programs executed by the protected subsystem. Since all secure

communications are at least in part encrypted and the processing inside the secure subsystem is concealed from outside observation and interference, the present invention ensures that content control information can be enforced. As a result, the creator and/or distributor and/or client administrator and/or other contributor of secure control information for each property (for example, an end-user restricting the kind of audit information he or she will allow to be reported and/or a financial clearinghouse establishing certain criteria for use of its credit for payment for use of distributed content) can be confident that their contributed and accepted control information will be enforced (within the security limitations of a given VDE security implementation design). This control information can determine, for example:

- (1) How and/or to whom electronic content can be provided, for example, how an electronic property can be distributed;
- (2) How one or more objects and/or properties, or portions of an object or property, can be directly used, such as decrypted, displayed, printed, etc;
- (3) How payment for usage of such content and/or content portions may or must be handled; and

- (4) How audit information about usage information related to at least a portion of a property should be collected, reported, and/or used.

5                   Seniority of contributed control information, including resolution of conflicts between content control information submitted by multiple parties, is normally established by:

- 10                   (1) the sequence in which control information is put in place by various parties (in place control information normally takes precedence over subsequently submitted control information),
- 15                   (2) the specifics of VDE content and/or appliance control information. For example, in-place control information can stipulate which subsequent one or more piece of control from one or more parties or class of parties will take precedence over control information submitted by one or more yet different
- 20                   parties and/or classes of parties, and/or
- (3) negotiation between control information sets from plural parties, which negotiation establishes what control information shall constitute the resulting

control information set for a given piece of VDE  
managed content and/or VDE installation.

### **Electronic Agreements and Rights Protection**

5           An important feature of VDE is that it can be used to  
assure the administration of, and adequacy of security and rights  
protection for, electronic agreements implemented through the  
use of the present invention. Such agreements may involve one  
or more of:

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(1) creators, publishers, and other distributors, of  
electronic information,

(2) financial service (e.g. credit) providers,

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(3) users of (other than financial service providers)  
information arising from content usage such as  
content specific demographic information and user  
specific descriptive information. Such users may  
20 include market analysts, marketing list compilers for  
direct and directed marketing, and government  
agencies,

20

(4) end users of content,

25

(5) infrastructure service and device providers such as telecommunication companies and hardware manufacturers (semiconductor and electronic appliance and/or other computer system manufacturers) who receive compensation based upon the use of their services and/or devices, and

(6) certain parties described by electronic information.

VDE supports commercially secure "extended" value chain electronic agreements. VDE can be configured to support the various underlying agreements between parties that comprise this extended agreement. These agreements can define important electronic commerce considerations including:

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(1) security,

(2) content use control, including electronic distribution,

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(3) privacy (regarding, for example, information concerning parties described by medical, credit, tax, personal, and/or of other forms of confidential information),

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(4) management of financial processes, and



- (5) pathways of handling for electronic content, content and/or appliance control information, electronic content and/or appliance usage information and payment and/or credit.

5

VDE agreements may define the electronic commerce relationship of two or more parties of a value chain, but such agreements may, at times, not directly obligate or otherwise directly involve other VDE value chain participants. For example, an electronic agreement between a content creator and a distributor may establish both the price to the distributor for a creator's content (such as for a property distributed in a VDE container object) and the number of copies of this object that this distributor may distribute to end-users over a given period of time. In a second agreement, a value chain end-user may be involved in a three party agreement in which the end-user agrees to certain requirements for using the distributed product such as accepting distributor charges for content use and agreeing to observe the copyright rights of the creator. A third agreement might exist between the distributor and a financial clearinghouse that allows the distributor to employ the clearinghouse's credit for payment for the product if the end-user has a separate (fourth) agreement directly with the clearinghouse extending credit to the end-user. A fifth, evolving agreement may develop between all value chain participants as content control

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information passes along its chain of handling. This evolving agreement can establish the rights of all parties to content usage information, including, for example, the nature of information to be received by each party and the pathway of handling of content usage information and related procedures. A sixth agreement in this example, may involve all parties to the agreement and establishes certain general assumptions, such as security techniques and degree of trustedness (for example, commercial integrity of the system may require each VDE installation secure subsystem to electronically warrant that their VDE node meets certain interoperability requirements). In the above example, these six agreements could comprise agreements of an extended agreement for this commercial value chain instance.

15           VDE agreements support evolving ("living") electronic agreement arrangements that can be modified by current and/or new participants through very simple to sophisticated "negotiations" between newly proposed content control information interacting with control information already in place and/or by negotiation between concurrently proposed content control information submitted by a plurality of parties. A given model may be asynchronously and progressively modified over time in accordance with existing senior rules and such modification may be applied to all, to classes of, and/or to specific content, and/or to classes and/or specific users and/or user nodes.

A given piece of content may be subject to different control information at different times or places of handling, depending on the evolution of its content control information (and/or on differing, applicable VDE installation content control information). The evolution of control information can occur during the passing along of one or more VDE control information containing objects, that is control information may be modified at one or more points along a chain of control information handling, so long as such modification is allowed. As a result, VDE managed content may have different control information applied at both different "locations" in a chain of content handling and at similar locations in differing chains of the handling of such content. Such different application of control information may also result from content control information specifying that a certain party or group of parties shall be subject to content control information that differs from another party or group of parties. For example, content control information for a given piece of content may be stipulated as senior information and therefore not changeable, might be put in place by a content creator and might stipulate that national distributors of a given piece of their content may be permitted to make 100,000 copies per calendar quarter, so long as such copies are provided to boni fide end-users, but may pass only a single copy of such content to a local retailers and the control information limits such a retailer to making no more than 1,000 copies per month for retail sales to

end-users. In addition, for example, an end-user of such content might be limited by the same content control information to making three copies of such content, one for each of three different computers he or she uses (one desktop computer at work, one for a desktop computer at home, and one for a portable computer).

Electronic agreements supported by the preferred embodiment of the present invention can vary from very simple to very elaborate. They can support widely diverse information management models that provide for electronic information security, usage administration, and communication and may support:

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- (a) secure electronic distribution of information, for example commercial literary properties,
- (b) secure electronic information usage monitoring and reporting,
- (c) secure financial transaction capabilities related to both electronic information and/or appliance usage and other electronic credit and/or currency usage and administration capabilities,

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- (d) privacy protection for usage information a user does not wish to release, and
- (e) "living" electronic information content dissemination models that flexibly accommodate:
- (1) a breadth of participants,
  - (2) one or more pathways (chains) for: the handling of content, content and/or appliance control information, reporting of content and/or appliance usage related information, and/or payment,
  - (3) supporting an evolution of terms and conditions incorporated into content control information, including use of electronic negotiation capabilities,
  - (4) support the combination of multiple pieces of content to form new content aggregations, and
  - (5) multiple concurrent models.

### Secure Processing Units

An important part of VDE provided by the present invention is the core secure transaction control arrangement, herein called an SPU (or SPUs), that typically must be present in each user's computer, other electronic appliance, or network. SPUs provide a trusted environment for generating decryption keys, encrypting and decrypting information, managing the secure communication of keys and other information between electronic appliances (i.e. between VDE installations and/or between plural VDE instances within a single VDE installation), securely accumulating and managing audit trail, reporting, and budget information in secure and/or non-secure non-volatile memory, maintaining a secure database of control information management instructions, and providing a secure environment for performing certain other control and administrative functions.

A hardware SPU (rather than a software emulation) within a VDE node is necessary if a highly trusted environment for performing certain VDE activities is required. Such a trusted environment may be created through the use of certain control software, one or more tamper resistant hardware modules such as a semiconductor or semiconductor chipset (including, for example, a tamper resistant hardware electronic appliance peripheral device), for use within, and/or operatively connected to, an electronic appliance. With the present invention, the

trustedness of a hardware SPU can be enhanced by enclosing some or all of its hardware elements within tamper resistant packaging and/or by employing other tamper resisting techniques (e.g. microfusing and/or thin wire detection techniques). A

5 trusted environment of the present invention implemented, in part, through the use of tamper resistant semiconductor design, contains control logic, such as a microprocessor, that securely executes VDE processes.

10 A VDE node's hardware SPU is a core component of a VDE secure subsystem and may employ some or all of an electronic appliance's primary control logic, such as a microcontroller, microcomputer or other CPU arrangement. This primary control logic may be otherwise employed for non VDE purposes such as

15 the control of some or all of an electronic appliance's non-VDE functions. When operating in a hardware SPU mode, said primary control logic must be sufficiently secure so as to protect and conceal important VDE processes. For example, a hardware SPU may employ a host electronic appliance microcomputer

20 operating in protected mode while performing VDE related activities, thus allowing portions of VDE processes to execute with a certain degree of security. This alternate embodiment is in contrast to the preferred embodiment wherein a trusted environment is created using a combination of one or more

25 tamper resistant semiconductors that are not part of said

primary control logic. In either embodiment, certain control information (software and parameter data) must be securely maintained within the SPU, and further control information can be stored externally and securely (e.g. in encrypted and tagged form) and loaded into said hardware SPU when needed. In many cases, and in particular with microcomputers, the preferred embodiment approach of employing special purpose secure hardware for executing said VDE processes, rather than using said primary control logic, may be more secure and efficient. The level of security and tamper resistance required for trusted SPU hardware processes depends on the commercial requirements of particular markets or market niches, and may vary widely.



**BRIEF DESCRIPTION OF THE DRAWINGS**

These and other features and advantages provided by the present invention(s) may be better and more completely understood by referring to the following detailed description of presently preferred example embodiments in connection with the drawings, of which:

FIGURE 1 illustrates an example of a "Virtual Distribution Environment" provided in accordance with a preferred example/embodiment of this invention;

FIGURE 1A is a more detailed illustration of an example of the "Information Utility" shown in FIGURE 1;

FIGURE 2 illustrates an example of a chain of handling and control;

FIGURE 2A illustrates one example of how rules and control information may persist from one participant to another in the Figure 2 chain of handling and control;

FIGURE 3 shows one example of different control information that may be provided;

FIGURE 4 illustrates examples of some different types of rules and/or control information;

FIGURES 5A and 5B show an example of an "object";

FIGURE 6 shows an example of a Secure Processing Unit ("SPU");

FIGURE 7 shows an example of an electronic appliance;

FIGURE 8 is a more detailed block diagram of an example of the electronic appliance shown in FIGURE 7;

FIGURE 9 is a detailed view of an example of the Secure Processing Unit (SPU) shown in FIGURES 6 and 8;

FIGURE 10 shows an example of a "Rights Operating System" ("ROS") architecture provided by the Virtual Distribution Environment;

FIGURES 11A-11C show examples of functional relationship(s) between applications and the Rights Operating System;

5           FIGURES 11D-11J show examples of "components" and "component assemblies";

FIGURE 12 is a more detailed diagram of an example of the Rights Operating System shown in FIGURE 10;

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FIGURE 12A shows an example of how "objects" can be created;

FIGURE 13 is a detailed block diagram of an example the software architecture for a "protected processing environment" shown in FIGURE 12;

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FIGURES 14A-14C are examples of SPU memory maps provided by the protected processing environment shown in FIGURE 13;

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FIGURE 15 illustrates an example of how the channel services manager and load module execution manager of FIGURE 13 can support a channel;

5           FIGURE 15A is an example of a channel header and channel detail records shown in FIGURE 15;

FIGURE 15B is a flowchart of an example of program control steps that may be performed by the FIGURE 13 protected  
10           processing environment to create a channel;

FIGURE 16 is a block diagram of an example of a secure data base structure;

15           FIGURE 17 is an illustration of an example of a logical object structure;

FIGURE 18 shows an example of a stationary object structure;

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FIGURE 19 shows an example of a traveling object structure;

FIGURE 20 shows an example of a content object structure;

FIGURE 21 shows an example of an administrative object structure;

FIGURE 22 shows an example of a method core structure;

FIGURE 23 shows an example of a load module structure;

FIGURE 24 shows an example of a User Data Element (UDE) and/or Method Data Element (MDE) structure;

FIGURES 25A-25C show examples of "map meters";

FIGURE 26 shows an example of a permissions record (PERC) structure;

FIGURES 26A and 26B together show a more detailed example of a permissions record structure;

FIGURE 27 shows an example of a shipping table structure;

5       FIGURE 28 shows an example of a receiving table structure;

FIGURE 29 shows an example of an administrative event log structure;

10       FIGURE 30 shows an example inter-relationship between and use of the object registration table, subject table and user rights table shown in the FIGURE 16 secure database;

15       FIGURE 31 is a more detailed example of an object registration table shown in FIGURE 16;

FIGURE 32 is a more detailed example of subject table shown in FIGURE 16;

20       FIGURE 33 is a more detailed example of a user rights table shown in FIGURE 16;

FIGURE 34 shows a specific example of how a site record table and group record table may track portions of the secure database shown in FIGURE 16;

5           FIGURE 34A is an example of a FIGURE 34 site record table structure;

FIGURE 34B is an example of a FIGURE 34 group record table structure;

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FIGURE 35 shows an example of a process for updating the secure database;

FIGURE 36 shows an example of how new elements may  
15           be inserted into the FIGURE 16 secure data base;

FIGURE 37 shows an example of how an element of the secure database may be accessed;

20           FIGURE 38 is a flowchart example of how to protect a secure database element;

FIGURE 39 is a flowchart example of how to back up a  
secure database;

5      FIGURE 40 is a flowchart example of how to recover a  
secure database from a backup;

10      FIGURES 41A-41D are a set of examples showing how a  
"chain of handling and control" may be enabled using "reciprocal  
methods";

15      FIGURES 42A-42D show an example of a "reciprocal"  
BUDGET method;

20      FIGURES 43A-43D show an example of a "reciprocal"  
REGISTER method;

25      FIGURES 44A-44C show an example of a "reciprocal"  
AUDIT method;

30      FIGURES 45-48 show examples of several methods being  
used together to control release of content or other information;



FIGURES 49, 49A-49F show an example OPEN method;

FIGURES 50, 50A-50F show an example of a READ  
method;

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FIGURES 51, 51A-51F show an example of a WRITE  
method;

FIGURE 52 shows an example of a CLOSE method;

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FIGURES 53A-53B show an example of an EVENT  
method;

FIGURE 53C shows an example of a BILLING method;

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FIGURE 54 shows an example of an ACCESS method;

FIGURES 55A-55B show examples of DECRYPT and  
ENCRYPT methods;

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FIGURE 56 shows an example of a CONTENT method;

FIGURES 57A and 57B show examples of EXTRACT and EMBED methods;

FIGURE 58A shows an example of an OBSCURE method;

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FIGURES 58B, 58C show examples of a FINGERPRINT method;

FIGURE 59 shows an example of a DESTROY method;

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FIGURE 60 shows an example of a PANIC method;

FIGURE 61 shows an example of a METER method;

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FIGURE 62 shows an example of a key "convolution" process;

FIGURE 63 shows an example of how different keys may be generated using a key convolution process to determine a "true" key;

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FIGURES 64 and 65 show an example of how protected processing environment keys may be initialized;

5        FIGURES 66 and 67 show example processes for decrypting information contained within stationary and traveling objects, respectively;

10        FIGURE 68 shows an example of how a protected processing environment may be initialized;

FIGURE 69 shows an example of how firmware may be downloaded into a protected processing environment;

15        FIGURE 70 shows an example of multiple VDE electronic appliances connected together with a network or other communications means;

20        FIGURE 71 shows an example of a portable VDE electronic appliance;

FIGURES 72A-72D show examples of "pop-up" displays that may be generated by the user notification and exception interface;

5           FIGURE 73 shows an example of a "smart object";

FIGURE 74 shows an example of a process using "smart objects";

10           FIGURES 75A-75D show examples of data structures used for electronic negotiation;

FIGURES 75E-75F show example structures relating to an electronic agreement;

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FIGURES 76A-76B show examples of electronic negotiation processes;

20           FIGURE 77 shows a further example of a chain of handling and control;

FIGURE 78 shows an example of a VDE "repository";

FIGURES 79-83 show an example illustrating a chain of handling and control to evolve and transform VDE managed content and control information;

5           FIGURE 84 shows a further example of a chain of handling and control involving several categories of VDE participants;

FIGURE 85 shows a further example of a chain of distribution and handling within an organization;

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Figures 86 and 86A show a further example of a chain of handling and control; and

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Figure 87 shows an example of a virtual silicon container model.

## **MORE DETAILED DESCRIPTION**

Figures 1-7 and the discussion below provides an overview of some aspects of features provided by this invention. Following this overview is a more technical "detail description" of example  
5       embodiments in accordance with the invention.

### **Overview**

10       Figure 1 shows a "Virtual Distribution Environment" ("VDE") 100 that may be provided in accordance with this invention. In Figure 1, an information utility 200 connects to communications means 202 such as telephone or cable TV lines for example. Telephone or cable TV lines 202 may be part of an  
15       "electronic highway" that carries electronic information from place to place. Lines 202 connect information utility 200 to other people

such as for example a consumer 208, an office 210, a video production studio 204, and a publishing house 214. Each of the people connected to information utility 200 may be called a "VDE participant" because they can participate in transactions occurring within the virtual distribution environment 100.

Almost any sort of transaction you can think of can be supported by virtual distribution environment 100. A few of many examples of transactions that can be supported by virtual distribution environment 100 include:

- C home banking and electronic payments;
- C electronic legal contracts;
- C distribution of "content" such as electronic printed matter, video, audio, images and computer programs; and
- C secure communication of private information such as medical records and financial information.

Virtual distribution environment 100 is "virtual" because it does not require many of the physical "things" that used to be necessary to protect rights, ensure reliable and predictable distribution, and ensure proper compensation to content creators and distributors. For example, in the past, information was

distributed on records or disks that were difficult to copy. In the past, private or secret content was distributed in sealed envelopes or locked briefcases delivered by courier. To ensure appropriate compensation, consumers received goods and services only after they handed cash over to a seller. Although information utility 200 may deliver information by transferring physical "things" such as electronic storage media, the virtual distribution environment 100 facilitates a completely electronic "chain of handling and control."

#### **VDE Flexibility Supports Transactions**

Information utility 200 flexibly supports many different kinds of information transactions. Different VDE participants may define and/or participate in different parts of a transaction. Information utility 200 may assist with delivering information about a transaction, or it may be one of the transaction participants.

For example, the video production studio 204 in the upper right-hand corner of Figure 1 may create video/television programs. Video production studio 204 may send these programs over lines 202, or may use other paths such as satellite



link 205 and CD ROM delivery service 216. Video production studio 204 can send the programs directly to consumers 206, 208, 210, or it can send the programs to information utility 200 which may store and later send them to the consumers, for example.

5 Consumers 206, 208, 210 are each capable of receiving and using the programs created by video production studio 204—assuming, that is, that the video production studio or information utility 200 has arranged for these consumers to have appropriate “rules and controls” (control information) that give the consumers rights to  
10 use the programs.

Even if a consumer has a copy of a video program, she cannot watch or copy the program unless she has “rules and controls” that authorize use of the program. She can use the  
15 program only as permitted by the “rules and controls.”

For example, video production studio 204 might release a half-hour exercise video in the hope that as many viewers as possible will view it. The video production studio 204 wishes to  
20 receive \$2.00 per viewing. Video production studio 204 may, through information utility 200, make the exercise video available in “protected” form to all consumers 206, 208, 210.

Video production studio 204 may also provide "rules and controls" for the video. These "rules and controls" may specify for example:

- 5           (1) any consumer who has good credit of at least \$2.00  
based on a credit account with independent financial  
provider 212 (such as Mastercard or VISA) may watch the  
video,
- 10           (2) virtual distribution environment 100 will "meter" each  
time a consumer watches the video, and report usage to  
video production studio 204 from time to time, and
- 15           (3) financial provider 212 may electronically collect  
payment (\$2.00) from the credit account of each consumer  
who watches the video, and transfer these payments to the  
video production studio 204.

Information utility 200 allows even a small video  
production studio to market videos to consumers and receive  
20           compensation for its efforts. Moreover, the videos can, with  
appropriate payment to the video production studio, be made

available to other video publishers who may add value and/or act as repackagers or redistributors.

Figure 1 also shows a publishing house 214. Publishing house 214 may act as a distributor for an author 206. The publishing house 214 may distribute rights to use "content" (such as computer software, electronic newspapers, the video produced by publishing house 214, audio, or any other data) to consumers such as office 210. The use rights may be defined by "rules and controls" distributed by publishing house 216. Publishing house 216 may distribute these "rules and controls" with the content, but this is not necessary. Because the content can be used only by consumers that have the appropriate "rules and controls," content and its associated "rules and controls" may be distributed at different times, in different ways, by different VDE participants. The ability of VDE to securely distribute and enforce "rules and controls" separately from the content they apply to provides great advantages.

Use rights distributed by publishing house 214 may, for example, permit office 210 to make and distribute copies of the content to its employees. Office 210 may act as a redistributor by

extending a "chain of handling and control" to its employees. The office 210 may add or modify "rules and controls" (consistent with the "rules and controls" it receives from publishing house 214) to provide office-internal control information and mechanisms. For example, office 210 may set a maximum usage budget for each individual user and/or group within the office, or it may permit only specified employees and/or groups to access certain information.

Figure 1 also shows an information delivery service 216 delivering electronic storage media such as "CD ROM" disks to consumers 206. Even though the electronic storage media themselves are not delivered electronically by information utility 200 over lines 202, they are still part of the virtual distribution environment 100. The electronic storage media may be used to distribute content, "rules and controls," or other information.

#### **Example of What's Inside Information Utility 200**

"Information utility" 200 in Figure 1 can be a collection of participants that may act as distributors, financial clearinghouses, and administrators. Figure 1A shows an example of what may be inside one example of information utility

200. Information utility participants 200a-200g could each be an independent organization/business. There can be any number of each of participants 200a-200g. In this example, electronic “switch” 200a connects internal parts of information utility 200 to each other and to outside participants, and may also connect outside participants to one another.

Information utility 200 may include a “transaction processor” 200b that processes transactions (to transfer electronic funds, for example) based on requests from participants and/or report receiver 200e. It may also include a “usage analyst” 200c that analyzes reported usage information. A “report creator” 200d may create reports based on usage for example, and may provide these reports to outside participants and/or to participants within information utility 200. A “report receiver” 200e may receive reports such as usage reports from content users. A “permissioning agent” 200f may distribute “rules and controls” granting usage or distribution permissions based on a profile of a consumer’s credit worthiness, for example. An administrator 200h may provide information that keeps the virtual distribution environment 100 operating properly. A

content and message storage 200g may store information for use  
by participants within or outside of information utility 200.

5      **Example of Distributing Content" Using A Chain of Handling  
and Control"**

As explained above, virtual distribution environment 100  
can be used to manage almost any sort of transaction. One type  
of important transaction that virtual distribution environment  
10      100 may be used to manage is the distribution or communication  
of "content" or other important information. Figure 2 more  
abstractly shows a "model" of how the Figure 1 virtual  
distribution environment 100 may be used to provide a "chain of  
handling and control" for distributing content. Each of the blocks  
15      in Figure 2 may correspond to one or more of the VDE  
participants shown in Figure 1.

In the Figure 2 example, a VDE content creator 102  
creates "content." The content creator 102 may also specify  
20      "rules and controls" for distributing the content. These  
distribution-related "rules and controls" can specify who has  
permission to distribute the rights to use content, and how many  
users are allowed to use the content.

Arrow 104 shows the content creator 102 sending the "rules and controls" associated with the content to a VDE rights distributor 106 ("distributor") over an electronic highway 108 (or by some other path such as an optical disk sent by a delivery service such as U. S. mail). The content can be distributed over the same or different path used to send the "rules and controls." The distributor 106 generates her own "rules and controls" that relate to usage of the content. The usage-related "rules and controls" may, for example, specify what a user can and can't do with the content and how much it costs to use the content. These usage-related "rules and controls" must be consistent with the "rules and controls" specified by content creator 102.

Arrow 110 shows the distributor 106 distributing rights to use the content by sending the content's "rules and controls" to a content user 112 such as a consumer. The content user 112 uses the content in accordance with the usage-related "rules and controls."

In this Figure 2 example, information relating to content use is, as shown by arrow 114, reported to a financial clearinghouse 116. Based on this "reporting," the financial

clearinghouse 116 may generate a bill and send it to the content user 112 over a "reports and payments" network 118. Arrow 120 shows the content user 112 providing payments for content usage to the financial clearinghouse 116. Based on the reports and payments it receives, the financial clearinghouse 116 may provide reports and/or payments to the distributor 106. The distributor 106 may, as shown by arrow 122, provide reports and/or payments to the content creator 102. The clearinghouse 116 may provide reports and payments directly to the creator 102. Reporting and/or payments may be done differently. For example, clearinghouse 116 may directly or through an agent, provide reports and/or payments to each of VDE content creators 102, and rights distributor 106, as well as reports to content user 112.

15

The distributor 106 and the content creator 102 may be the same person, or they may be different people. For example, a musical performing group may act as both content creator 102 and distributor 106 by creating and distributing its own musical recordings. As another example, a publishing house may act as a distributor 106 to distribute rights to use works created by an author content creator 102. Content creators 102 may use a

20



distributor 106 to efficiently manage the financial end of content distribution.

The "financial clearinghouse" 116 shown in Figure 2 may also be a "VDE administrator." Financial clearinghouse 116 in its VDE administrator role sends "administrative" information to the VDE participants. This administrative information helps to keep the virtual distribution environment 100 operating properly. The "VDE administrator" and financial clearinghouse roles may be performed by different people or companies, and there can be more than one of each.

#### **More about Rules and Controls"**

The virtual distribution environment 100 prevents use of protected information except as permitted by the "rules and controls" (control information). For example, the "rules and controls" shown in Figure 2 may grant specific individuals or classes of content users 112 "permission" to use certain content. They may specify what kinds of content usage are permitted, and what kinds are not. They may specify how content usage is to be paid for and how much it costs. As another example, "rules and

controls" may require content usage information to be reported back to the distributor 106 and/or content creator 102.

- 5           Every VDE participant in "chain of handling and control" is normally subject to "rules and controls." "Rules and controls" define the respective rights and obligations of each of the various VDE participants. "Rules and controls" provide information and mechanisms that may establish interdependencies and relationships between the participants. "Rules and controls" are flexible, and permit "virtual distribution environment" 100 to support most "traditional" business transactions. For example:
- 10           C     "Rules and controls" may specify which financial clearinghouse(s) 116 may process payments,
- C     "Rules and controls" may specify which participant(s) receive what kind of usage report, and
- 15           C     "Rules and controls" may specify that certain information is revealed to certain participants, and that other information is kept secret from them.
- 20           "Rules and controls" may self limit if and how they may be changed. Often, "rules and controls" specified by one VDE participant cannot be changed by another VDE participant. For

example, a content user 112 generally can't change "rules and controls" specified by a distributor 106 that require the user to pay for content usage at a certain rate. "Rules and controls" may "persist" as they pass through a "chain of handling and control," and may be "inherited" as they are passed down from one VDE participant to the next.

Depending upon their needs, VDE participants can specify that their "rules and controls" can be changed under conditions specified by the same or other "rules and controls." For example, "rules and controls" specified by the content creator 102 may permit the distributor 106 to "mark up" the usage price just as retail stores "mark up" the wholesale price of goods. Figure 2A shows an example in which certain "rules and controls" persist unchanged from content creator 102 to content user 112; other "rules and controls" are modified or deleted by distributor 106; and still other "rules and controls" are added by the distributor.

"Rules and controls" can be used to protect the content user's privacy by limiting the information that is reported to other VDE participants. As one example, "rules and controls" can cause content usage information to be reported anonymously

without revealing content user identity, or it can reveal only certain information to certain participants (for example, information derived from usage) with appropriate permission, if required. This ability to securely control what information is revealed and what VDE participant(s) it is revealed to allows the privacy rights of all VDE participants to be protected.

#### **Rules and Contents" Can Be Separately Delivered**

As mentioned above, virtual distribution environment 100 "associates" content with corresponding "rules and controls," and prevents the content from being used or accessed unless a set of corresponding "rules and controls" is available. The distributor 106 doesn't need to deliver content to control the content's distribution. The preferred embodiment can securely protect content by protecting corresponding, usage enabling "rules and controls" against unauthorized distribution and use.

In some examples, "rules and controls" may travel with the content they apply to. Virtual distribution environment 100 also allows "rules and controls" to be delivered separately from content. Since no one can use or access protected content without "permission" from corresponding "rules and controls," the

distributor 106 can control use of content that has already been (or will in the future be) delivered. "Rules and controls" may be delivered over a path different from the one used for content delivery. "Rules and controls" may also be delivered at some other time. The content creator 102 might deliver content to content user 112 over the electronic highway 108, or could make the content available to anyone on the highway. Content may be used at the time it is delivered, or it may be stored for later use or reuse.

The virtual distribution environment 100 also allows payment and reporting means to be delivered separately. For example, the content user 112 may have a virtual "credit card" that extends credit (up to a certain limit) to pay for usage of any content. A "credit transaction" can take place at the user's site without requiring any "online" connection or further authorization. This invention can be used to help securely protect the virtual "credit card" against unauthorized use.

## **Rules and Contents" Define Processes**

Figure 3 shows an example of an overall process based on "rules and controls." It includes an "events" process 402, a meter

process 404, a billing process 406, and a budget process 408. Not all of the processes shown in Figure 3 will be used for every set of "rules and controls."

5           The "events process" 402 detects things that happen ("events") and determines which of those "events" need action by the other "processes." The "events" may include, for example, a request to use content or generate a usage permission. Some events may need additional processing, and others may not.

10          Whether an "event" needs more processing depends on the "rules and controls" corresponding to the content. For example, a user who lacks permission will not have her request satisfied ("No Go"). As another example, each user request to turn to a new page of an electronic book may be satisfied ("Go"), but it may not

15          be necessary to meter, bill or budget those requests. A user who has purchased a copy of a novel may be permitted to open and read the novel as many times as she wants to without any further metering, billing or budgeting. In this simple example, the "event process" 402 may request metering, billing and/or

20          budgeting processes the first time the user asks to open the protected novel (so the purchase price can be charged to the user), and treat all later requests to open the same novel as

“insignificant events.” Other content (for example, searching an electronic telephone directory) may require the user to pay a fee for each access.

5           “Meter” process 404 keeps track of events, and may report usage to distributor 106 and/or other appropriate VDE participant(s). Figure 4 shows that process 404 can be based on a number of different factors such as:

- (a) type of usage to charge for,
- 10       (b) what kind of unit to base charges on,
- (c) how much to charge per unit,
- (d) when to report, and
- (e) how to pay.

These factors may be specified by the “rules and controls” that  
15       control the meter process.

Billing process 406 determines how much to charge for events. It records and reports payment information.

20           Budget process 408 limits how much content usage is permitted. For example, budget process 408 may limit the number of times content may be accessed or copied, or it may

limit the number of pages or other amount of content that can be used based on, for example, the number of dollars available in a credit account. Budget process 408 records and reports financial and other transaction information associated with such limits.

5

Content may be supplied to the user once these processes have been successfully performed.

#### Containers and Objects

10

Figure 5A shows how the virtual distribution environment 100, in a preferred embodiment, may package information elements (content) into a "container" 302 so the information can't be accessed except as provided by its "rules and controls."

Normally, the container 302 is electronic rather than physical.

15

Electronic container 302 in one example comprises "digital" information having a well defined structure. Container 302 and its contents can be called an "object 300."

20

The Figure 5A example shows items "within" and enclosed by container 302. However, container 302 may "contain" items without those items actually being stored within the container. For example, the container 302 may reference items that are



available elsewhere such as in other containers at remote sites.

Container 302 may reference items available at different times or only during limited times. Some items may be too large to store within container 302. Items may, for example, be delivered to the user in the form of a "live feed" of video at a certain time. Even then, the container 302 "contains" the live feed (by reference) in this example.

Container 302 may contain information content 304 in electronic (such as "digital") form. Information content 304 could be the text of a novel, a picture, sound such as a musical performance or a reading, a movie or other video, computer software, or just about any other kind of electronic information you can think of. Other types of "objects" 300 (such as "administrative objects") may contain "administrative" or other information instead of or in addition to information content 304.

In the Figure 5A example, container 302 may also contain "rules and controls" in the form of:

- (a) a "permissions record" 808;
- (b) "budgets" 308; and
- (c) "other methods" 1000.

Figure 5B gives some additional detail about permissions record 808, budgets 308 and other methods 1000. The "permissions record" 808 specifies the rights associated with the object 300 such as, for example, who can open the container 302, who can use the object's contents, who can distribute the object, and what other control mechanisms must be active. For example, permissions record 808 may specify a user's rights to use, distribute and/or administer the container 302 and its content. Permissions record 808 may also specify requirements to be applied by the budgets 308 and "other methods" 1000. Permissions record 808 may also contain security related information such as scrambling and descrambling "keys."

"Budgets" 308 shown in Figure 5B are a special type of "method" 1000 that may specify, among other things, limitations on usage of information content 304, and how usage will be paid for. Budgets 308 can specify, for example, how much of the total information content 304 can be used and/or copied. The methods 310 may prevent use of more than the amount specified by a specific budget.

“Other methods” 1000 define basic operations used by “rules and controls.” Such “methods” 1000 may include, for example, how usage is to be “metered,” if and how content 304 and other information is to be scrambled and descrambled, and other processes associated with handling and controlling information content 304. For example, methods 1000 may record the identity of anyone who opens the electronic container 302, and can also control how information content is to be charged based on “metering.” Methods 1000 may apply to one or several different information contents 304 and associated containers 302, as well as to all or specific portions of information content 304.

#### **Secure Processing Unit (SPU)**

The “VDE participants” may each have an “electronic appliance.” The appliance may be or contain a computer. The appliances may communicate over the electronic highway 108. Figure 6 shows a secure processing unit (“SPU”) 500 portion of the “electronic appliance” used in this example by each VDE participant. SPU 500 processes information in a secure processing environment 503, and stores important information securely. SPU 500 may be emulated by software operating in a host electronic appliance.

SPU 500 is enclosed within and protected by a "tamper resistant security barrier" 502. Security barrier 502 separates the secure environment 503 from the rest of the world. It prevents information and processes within the secure environment 503 from being observed, interfered with and leaving except under appropriate secure conditions. Barrier 502 also controls external access to secure resources, processes and information within SPU 500. In one example, tamper resistant security barrier 502 is formed by security features such as "encryption," and hardware that detects tampering and/or destroys sensitive information within secure environment 503 when tampering is detected.

SPU 500 in this example is an integrated circuit ("IC") "chip" 504 including "hardware" 506 and "firmware" 508. SPU 500 connects to the rest of the electronic appliance through an "appliance link" 510. SPU "firmware" 508 in this example is "software" such as a "computer program(s)" "embedded" within chip 504. Firmware 508 makes the hardware 506 work. Hardware 506 preferably contains a processor to perform instructions specified by firmware 508. "Hardware" 506 also contains long-term and short-term memories to store information

securely so it can't be tampered with. SPU 500 may also have a protected clock/calendar used for timing events. The SPU hardware 506 in this example may include special purpose electronic circuits that are specially designed to perform certain processes (such as "encryption" and "decryption") rapidly and efficiently.

The particular context in which SPU 500 is being used will determine how much processing capabilities SPU 500 should have. SPU hardware 506, in this example, provides at least enough processing capabilities to support the secure parts of processes shown in Figure 3. In some contexts, the functions of SPU 500 may be increased so the SPU can perform all the electronic appliance processing, and can be incorporated into a general purpose processor. In other contexts, SPU 500 may work alongside a general purpose processor, and therefore only needs to have enough processing capabilities to handle secure processes.

**VDE Electronic Appliance and Rights Operating System"**

Figure 7 shows an example of an electronic appliance 600 including SPU 500. Electronic appliance 600 may be practically any kind of electrical or electronic device, such as:

5

C a computer

C a T.V. "set top" control box

C a pager

C a telephone

10

C a sound system

C a video reproduction system

C a video game player

C a "smart" credit card

15

Electronic appliance 600 in this example may include a keyboard or keypad 612, a voice recognizer 613, and a display 614. A

human user can input commands through keyboard 612 and/or

voice recognizer 613, and may view information on display 614.

Appliance 600 may communicate with the outside world through

20

any of the connections/devices normally used within an electronic appliance. The connections/devices shown along the bottom of the drawing are examples:

a "modem" 618 or other telecommunications link;  
a CD ROM disk 620 or other storage medium or device;  
a printer 622;  
broadcast reception 624;  
5 a document scanner 626; and  
a "cable" 628 connecting the appliance with a "network."

Virtual distribution environment 100 provides a "rights  
operating system" 602 that manages appliance 600 and SPU 500  
10 by controlling their hardware resources. The operating system  
602 may also support at least one "application" 608. Generally,  
"application" 608 is hardware and/or software specific to the  
context of appliance 600. For example, if appliance 600 is a  
personal computer, then "application" 608 could be a program  
15 loaded by the user, for instance, a word processor, a  
communications system or a sound recorder. If appliance 600 is a  
television controller box, then application 608 might be hardware  
or software that allows a user to order videos on demand and  
perform other functions such as fast forward and rewind. In this  
20 example, operating system 602 provides a standardized, well  
defined, generalized "interface" that could support and work  
with many different "applications" 608.

Operating system 602 in this example provides "rights and auditing operating system functions" 604 and "other operating system functions" 606. The "rights and auditing operating system functions" 604 securely handle tasks that relate to virtual distribution environment 100. SPU 500 provides or supports many of the security functions of the "rights and auditing operating system functions" 402. The "other operating system functions" 606 handle general appliance functions. Overall operating system 602 may be designed from the beginning to include the "rights and auditing operating system functions" 604 plus the "other operating system functions" 606, or the "rights and auditing operating system functions" may be an add-on to a preexisting operating system providing the "other operating system functions."

"Rights operating system" 602 in this example can work with many different types of appliances 600. For example, it can work with large mainframe computers, "minicomputers" and "microcomputers" such as personal computers and portable computing devices. It can also work in control boxes on the top of television sets, small portable "pagers," desktop radios, stereo sound systems, telephones, telephone switches, or any other



electronic appliance. This ability to work on big appliances as well as little appliances is called "scalable." A "scalable" operating system 602 means that there can be a standardized interface across many different appliances performing a wide  
5 variety of tasks.

The "rights operating system functions" 604 are "services-based" in this example. For example, "rights operating system functions" 604 handle summary requests from application 608  
10 rather than requiring the application to always make more detailed "subrequests" or otherwise get involved with the underlying complexities involved in satisfying a summary request. For example, application 608 may simply ask to read specified information; "rights operating system functions" 604  
15 can then decide whether the desired information is VDE-protected content and, if it is, perform processes needed to make the information available. This feature is called "transparency." "Transparency" makes tasks easy for the application 608. "Rights operating system functions" 604 can support applications  
20 608 that "know" nothing about virtual distribution environment 100. Applications 608 that are "aware" of virtual distribution

environment 100 may be able to make more detailed use of  
virtual distribution environment 100.

5           In this example, "rights operating system functions" 604  
are "event driven". Rather than repeatedly examining the state  
of electronic appliance 600 to determine whether a condition has  
arisen, the "rights operating system functions" 604 may respond  
directly to "events" or "happenings" within appliance 600.

10           In this example, some of the services performed by "rights  
operating system functions" 604 may be extended based on  
additional "components" delivered to operating system 602.  
"Rights operating system functions" 604 can collect together and  
use "components" sent by different participants at different  
15           times. The "components" help to make the operating system 602  
"scalable." Some components can change how services work on  
little appliances versus how they work on big appliances (e.g.,  
multi-user). Other components are designed to work with specific  
applications or classes of applications (e.g., some types of meters  
20           and some types of budgets).

#### **Electronic Appliance 600**

An electronic appliance 600 provided by the preferred embodiment may, for example, be any electronic apparatus that contains one or more microprocessors and/or microcontrollers and/or other devices which perform logical and/or mathematical calculations. This may include computers; computer terminals; 5 device controllers for use with computers; peripheral devices for use with computers; digital display devices; televisions; video and audio/video projection systems; channel selectors and/or decoders for use with broadcast and/or cable transmissions; remote control devices; video and/or audio recorders; media players including 10 compact disc players, videodisc players and tape players; audio and/or video amplifiers; virtual reality machines; electronic game players; multimedia players; radios; telephones; videophones; facsimile machines; robots; numerically controlled machines including machine tools and the like; and other devices 15 containing one or more microcomputers and/or microcontrollers and/or other CPUs, including those not yet in existence.

Figure 8 shows an example of an electronic appliance 600. 20 This example of electronic appliance 600 includes a system bus 653. In this example, one or more conventional general purpose central processing units ("CPUs") 654 are connected to bus 653.

Bus 653 connects CPU(s) 654 to RAM 656, ROM 658, and I/O controller 660. One or more SPUs 500 may also be connected to system bus 653. System bus 653 may permit SPU(s) 500 to communicate with CPU(s) 654, and also may allow both the CPU(s) and the SPU(s) to communicate (e.g., over shared address and data lines) with RAM 656, ROM 658 and I/O controller 660. A power supply 659 may provide power to SPU 500, CPU 654 and the other system components shown.

10           In the example shown, I/O controller 660 is connected to secondary storage device 652, a keyboard/display 612,614, a communications controller 666, and a backup storage device 668. Backup storage device 668 may, for example, store information on mass media such as a tape 670, a floppy disk, a removable  
15           memory card, etc. Communications controller 666 may allow electronic appliance 600 to communicate with other electronic appliances via network 672 or other telecommunications links. Different electronic appliances 600 may interoperate even if they use different CPUs and different instances of ROS 602, so long as  
20           they typically use compatible communication protocols and/or security methods. In this example, I/O controller 660 permits CPU 654 and SPU 500 to read from and write to secondary

storage 662, keyboard/display 612, 614, communications controller 666, and backup storage device 668.

5           Secondary storage 662 may comprise the same one or more non-secure secondary storage devices (such as a magnetic disk and a CD-ROM drive as one example) that electronic appliance 600 uses for general secondary storage functions. In some implementations, part or all of secondary storage 652 may comprise a secondary storage device(s) that is physically enclosed  
10           within a secure enclosure. However, since it may not be practical or cost-effective to physically secure secondary storage 652 in many implementations, secondary storage 652 may be used to store information in a secure manner by encrypting information before storing it in secondary storage 652. If information is  
15           encrypted before it is stored, physical access to secondary storage 652 or its contents does not readily reveal or compromise the information.

20           Secondary storage 652 in this example stores code and data used by CPU 654 and/or SPU 500 to control the overall operation of electronic appliance 600. For example, Figure 8 shows that "Rights Operating System" ("ROS") 602 (including a

portion 604 of ROS that provides VDE functions and a portion  
606 that provides other OS functions) shown in Figure 7 may be  
stored on secondary storage 652. Secondary storage 652 may  
also store one or more VDE objects 300. Figure 8 also shows that  
5 the secure files 610 shown in Figure 7 may be stored on  
secondary storage 652 in the form of a "secure database" or  
management file system 610. This secure database 610 may  
store and organize information used by ROS 602 to perform VDE  
functions 604. Thus, the code that is executed to perform VDE  
10 and other OS functions 604, 606, and secure files 610 (as well as  
VDE objects 300) associated with those functions may be stored  
in secondary storage 652. Secondary storage 652 may also store  
"other information" 673 such as, for example, information used by  
other operating system functions 606 for task management, non-  
15 VDE files, etc. Portions of the elements indicated in secondary  
storage 652 may also be stored in ROM 658, so long as those  
elements do not require changes (except when ROM 658 is  
replaced). Portions of ROS 602 in particular may desirably be  
included in ROM 658 (e.g., "bootstrap" routines, POST routines,  
20 etc. for use in establishing an operating environment for  
electronic appliance 600 when power is applied).

Figure 8 shows that secondary storage 652 may also be used to store code ("application programs") providing user application(s) 608 shown in Figure 7. Figure 8 shows that there may be two general types of application programs 608: "VDE aware" applications 608a, and Non-VDE aware applications 608b. VDE aware applications 608a may have been at least in part designed specifically with VDE 100 in mind to access and take detailed advantage of VDE functions 604. Because of the "transparency" features of ROS 602, non-VDE aware applications 608b (e.g., applications not specifically designed for VDE 100) can also access and take advantage of VDE functions 604.

#### **SECURE PROCESSING UNIT 500**

Each VDE node or other electronic appliance 600 in the preferred embodiment may include one or more SPUs 500. SPUs 500 may be used to perform all secure processing for VDE 100. For example, SPU 500 is used for decrypting (or otherwise unsecuring) VDE protected objects 300. It is also used for managing encrypted and/or otherwise secured communication (such as by employing authentication and/or error-correction validation of information). SPU 500 may also perform secure data management processes including governing usage of,

auditing of, and where appropriate, payment for VDE objects 300 (through the use of prepayments, credits, real-time electronic debits from bank accounts and/or VDE node currency token deposit accounts). SPU 500 may perform other transactions  
5 related to such VDE objects 300.

#### SPU Physical Packaging and Security Barrier 502

As shown Figure 6, in the preferred embodiment, an SPU 500 may be implemented as a single integrated circuit "chip" 505  
10 to provide a secure processing environment in which confidential and/or commercially valuable information can be safely processed, encrypted and/or decrypted. IC chip 505 may, for example, comprise a small semiconductor "die" about the size of a thumbnail. This semiconductor die may include semiconductor  
15 and metal conductive pathways. These pathways define the circuitry, and thus the functionality, of SPU 500. Some of these pathways are electrically connected to the external "pins" 504 of the chip 505.

20 As shown in Figures 6 and 9, SPU 500 may be surrounded by a tamper-resistant hardware security barrier 502. Part of this security barrier 502 is formed by a plastic or other package in



which an SPU "die" is encased. Because the processing occurring within, and information stored by, SPU 500 are not easily accessible to the outside world, they are relatively secure from unauthorized access and tampering. All signals cross barrier 502 through a secure, controlled path provided by BIU 530 that restricts the outside world's access to the internal components within SPU 500. This secure, controlled path resists attempts from the outside world to access secret information and resources within SPU 500.

It is possible to remove the plastic package of an IC chip and gain access to the "die." It is also possible to analyze and "reverse engineer" the "die" itself (e.g., using various types of logic analyzers and microprobes to collect and analyze signals on the die while the circuitry is operating, using acid etching or other techniques to remove semiconductor layers to expose other layers, viewing and photographing the die using an electron microscope, etc.) Although no system or circuit is absolutely impervious to such attacks, SPU barrier 502 may include additional hardware protections that make successful attacks exceedingly costly and time consuming. For example, ion implantation and/or other fabrication techniques may be used to

make it very difficult to visually discern SPU die conductive pathways, and SPU internal circuitry may be fabricated in such a way that it "self-destructs" when exposed to air and/or light. SPU 500 may store secret information in internal memory that loses its contents when power is lost. Circuitry may be incorporated within SPU 500 that detects microprobing or other tampering, and self-destructs (or destroys other parts of the SPU) when tampering is detected. These and other hardware-based physical security techniques contribute to tamper-resistant hardware security barrier 502.

To increase the security of security barrier 502 even further, it is possible to encase or include SPU 500 in one or more further physical enclosures such as, for example: epoxy or other "potting compound"; further module enclosures including additional self-destruct, self-disabling or other features activated when tampering is detected; further modules providing additional security protections such as requiring password or other authentication to operate; and the like. In addition, further layers of metal may be added to the die to complicate acid etching, micro probing, and the like; circuitry designed to "zeroize" memory may be included as an aspect of self-destruct

processes; the plastic package itself may be designed to resist chemical as well as physical "attacks"; and memories internal to SPU 500 may have specialized addressing and refresh circuitry that "shuffles" the location of bits to complicate efforts to electrically determine the value of memory locations. These and other techniques may contribute to the security of barrier 502.

In some electronic appliances 600, SPU 500 may be integrated together with the device microcontroller or equivalent or with a device I/O or communications microcontroller into a common chip (or chip set) 505. For example, in one preferred embodiment, SPU 500 may be integrated together with one or more other CPU(s) (e.g., a CPU 654 of an electronic appliance) in a single component or package. The other CPU(s) 654 may be any centrally controlling logic arrangement, such as for example, a microprocessor, other microcontroller, and/or array or other parallel processor. This integrated configuration may result in lower overall cost, smaller overall size, and potentially faster interaction between an SPU 500 and a CPU 654. Integration may also provide wider distribution if an integrated SPU/CPU component is a standard feature of a widely distributed microprocessor line. Merging an SPU 500 into a main CPU 654

of an electronic appliance 600 (or into another appliance or  
appliance peripheral microcomputer or other microcontroller)  
may substantially reduce the overhead cost of implementing VDE  
100. Integration considerations may include cost of  
5 implementation, cost of manufacture, desired degree of security,  
and value of compactness.

SPU 500 may also be integrated with devices other than  
CPUs. For example, for video and multimedia applications, some  
10 performance and/or security advantages (depending on overall  
design) could result from integrating an SPU 500 into a video  
controller chip or chipset. SPU 500 can also be integrated  
directly into a network communications chip or chipset or the  
like. Certain performance advantages in high speed  
15 communications applications may also result from integrating an  
SPU 500 with a modem chip or chipset. This may facilitate  
incorporation of an SPU 500 into communication appliances such  
as stand-alone fax machines. SPU 500 may also be integrated  
into other peripheral devices, such as CD-ROM devices, set-top  
20 cable devices, game devices, and a wide variety of other electronic  
appliances that use, allow access to, perform transactions related  
to, or consume, distributed information.

### SPU 500 Internal Architecture

Figure 9 is a detailed diagram of the internal structure within an example of SPU 500. SPU 500 in this example includes a single microprocessor 520 and a limited amount of memory configured as ROM 532 and RAM 534. In more detail, this example of SPU 500 includes microprocessor 520, an encrypt/decrypt engine 522, a DMA controller 526, a real-time clock 528, a bus interface unit ("BIU") 530, a read only memory (ROM) 532, a random access memory (RAM) 534, and a memory management unit ("MMU") 540. DMA controller 526 and MMU 540 are optional, but the performance of SPU 500 may suffer if they are not present. SPU 500 may also include an optional pattern matching engine 524, an optional random number generator 542, an optional arithmetic accelerator circuit 544, and optional compression/decompression circuit 546. A shared address/data bus arrangement 536 may transfer information between these various components under control of microprocessor 520 and/or DMA controller 526. Additional or alternate dedicated paths 538 may connect microprocessor 520 to the other components (e.g., encrypt/decrypt engine 522 via line 538a, real-time clock 528 via line 538b, bus interface unit 530 via

line 538c, DMA controller via line 538d, and memory management unit (MMU) 540 via line 538e).

5           The following section discusses each of these SPU components in more detail.

### **Microprocessor 520**

Microprocessor 520 is the "brain" of SPU 500. In this example, it executes a sequence of steps specified by code stored  
10   (at least temporarily) within ROM 532 and/or RAM 534.

Microprocessor 520 in the preferred embodiment comprises a dedicated central processing arrangement (e.g., a RISC and/or CISC processor unit, a microcontroller, and/or other central processing means or, less desirably in most applications, process  
15   specific dedicated control logic) for executing instructions stored in the ROM 532 and/or other memory. Microprocessor 520 may be separate elements of a circuitry layout, or may be separate packages within a secure SPU 500.

20           In the preferred embodiment, microprocessor 520 normally handles the most security sensitive aspects of the operation of electronic appliance 600. For example, microprocessor 520 may

manage VDE decrypting, encrypting, certain content and/or appliance usage control information, keeping track of usage of VDE secured content, and other VDE usage control related functions.

5

Stored in each SPU 500 and/or electronic appliance secondary memory 652 may be, for example, an instance of ROS 602 software, application programs 608, objects 300 containing VDE controlled property content and related information, and management database 610 that stores both information associated with objects and VDE control information. ROS 602 includes software intended for execution by SPU microprocessor 520 for, in part, controlling usage of VDE related objects 300 by electronic appliance 600. As will be explained, these SPU programs include "load modules" for performing basic control functions. These various programs and associated data are executed and manipulated primarily by microprocessor 520.

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#### **Real Time Clock (RTC) 528**

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In the preferred embodiment, SPU 500 includes a real time clock circuit ("RTC") 528 that serves as a reliable, tamper resistant time base for the SPU. RTC 528 keeps track of time of

day and date (e.g., month, day and year) in the preferred embodiment, and thus may comprise a combination calendar and clock. A reliable time base is important for implementing time based usage metering methods, "time aged decryption keys," and other time based SPU functions.

The RTC 528 must receive power in order to operate. Optimally, the RTC 528 power source could comprise a small battery located within SPU 500 or other secure enclosure. However, the RTC 528 may employ a power source such as an externally located battery that is external to the SPU 500. Such an externally located battery may provide relatively uninterrupted power to RTC 528, and may also maintain as non-volatile at least a portion of the otherwise volatile RAM 534 within SPU 500.

In one implementation, electronic appliance power supply 659 is also used to power SPU 500. Using any external power supply as the only power source for RTC 528 may significantly reduce the usefulness of time based security techniques unless, at minimum, SPU 500 recognizes any interruption (or any material interruption) of the supply of external power, records such



interruption, and responds as may be appropriate such as disabling the ability of the SPU 500 to perform certain or all VDE processes. Recognizing a power interruption may, for example, be accomplished by employing a circuit which is activated by power failure. The power failure sensing circuit may power another circuit that includes associated logic for recording one or more power fail events. Capacitor discharge circuitry may provide the necessary temporary power to operate this logic. In addition or alternatively, SPU 500 may from time to time compare an output of RTC 528 to a clock output of a host electronic appliance 600, if available. In the event a discrepancy is detected, SPU 500 may respond as appropriate, including recording the discrepancy and/or disabling at least some portion of processes performed by SPU 500 under at least some circumstances.

If a power failure and/or RTC 528 discrepancy and/or other event indicates the possibility of tampering, SPU 500 may automatically destroy, or render inaccessible without privileged intervention, one or more portions of sensitive information it stores, such as execution related information and/or encryption key related information. To provide further SPU operation, such

destroyed information would have to be replaced by a VDE clearinghouse, administrator and/or distributor, as may be appropriate. This may be achieved by remotely downloading update and/or replacement data and/or code. In the event of a  
5 disabling and/or destruction of processes and/or information as described above, the electronic appliance 600 may require a secure VDE communication with an administrator, clearinghouse, and/or distributor as appropriate in order to reinitialize the RTC 528. Some or all secure SPU 500 processes  
10 may not operate until then.

It may be desirable to provide a mechanism for setting and/or synchronizing RTC 528. In the preferred embodiment, when communication occurs between VDE electronic appliance 600 and another VDE appliance, an output of RTC 528 may be  
15 compared to a controlled RTC 528 output time under control of the party authorized to be "senior" and controlling. In the event of a discrepancy, appropriate action may be taken, including resetting the RTC 528 of the "junior" controlled participant in the communication.

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#### **SPU Encrypt/Decrypt Engine 522**

In the preferred embodiment, SPU encrypt/decrypt engine 522 provides special purpose hardware (e.g., a hardware state machine) for rapidly and efficiently encrypting and/or decrypting data. In some implementations, the encrypt/decrypt functions may be performed instead by microprocessor 520 under software control, but providing special purpose encrypt/decrypt hardware engine 522 will, in general, provide increased performance. Microprocessor 520 may, if desired, comprise a combination of processor circuitry and dedicated encryption/decryption logic that may be integrated together in the same circuitry layout so as to, for example, optimally share one or more circuit elements.

Generally, it is preferable that a computationally efficient but highly secure "bulk" encryption/decryption technique should be used to protect most of the data and objects handled by SPU 500. It is preferable that an extremely secure encryption/decryption technique be used as an aspect of authenticating the identity of electronic appliances 600 that are establishing a communication channel and securing any transferred permission, method, and administrative information. In the preferred embodiment, the encrypt/decrypt engine 522 includes both a symmetric key encryption/decryption circuit (e.g.

DES, Skipjack/Clipper, IDEA, RC-2, RC-4, etc.) and an antisymmetric (asymmetric) or Public Key ("PK") encryption/decryption circuit. The public/private key encryption/decryption circuit is used principally as an aspect of secure communications between an SPU 500 and VDE administrators, or other electronic appliances 600, that is between VDE secure subsystems. A symmetric encryption/decryption circuit may be used for "bulk" encrypting and decrypting most data stored in secondary storage 662 of electronic appliance 600 in which SPU 500 resides. The symmetric key encryption/decryption circuit may also be used for encrypting and decrypting content stored within VDE objects 300.

DES or public/private key methods may be used for all encryption functions. In alternate embodiments, encryption and decryption methods other than the DES and public/private key methods could be used for the various encryption related functions. For instance, other types of symmetric encryption/decryption techniques in which the same key is used for encryption and decryption could be used in place of DES encryption and decryption. The preferred embodiment can

support a plurality of decryption/encryption techniques using multiple dedicated circuits within encrypt/decrypt engine 522 and/or the processing arrangement within SPU 500.

5                   **Pattern Matching Engine 524**

Optional pattern matching engine 524 may provide special purpose hardware for performing pattern matching functions.

One of the functions SPU 500 may perform is to validate/authenticate VDE objects 300 and other items.

10           Validation/authentication often involves comparing long data strings to determine whether they compare in a predetermined way. In addition, certain forms of usage (such as logical and/or physical (contiguous) relatedness of accessed elements) may require searching potentially long strings of data for certain bit  
15           patterns or other significant pattern related metrics. Although pattern matching can be performed by SPU microprocessor 520 under software control, providing special purpose hardware pattern matching engine 524 may speed up the pattern matching process.

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**Compression/Decompression Engine 546**

An optional compression/decompression engine 546 may be provided within an SPU 500 to, for example, compress and/or decompress content stored in, or released from, VDE objects 300.

Compression/decompression engine 546 may implement one or more compression algorithms using hardware circuitry to improve the performance of compression/decompression operations that would otherwise be performed by software operating on microprocessor 520, or outside SPU 500.

Decompression is important in the release of data such as video and audio that is usually compressed before distribution and whose decompression speed is important. In some cases, information that is useful for usage monitoring purposes (such as record separators or other delimiters) is "hidden" under a compression layer that must be removed before this information can be detected and used inside SPU 500.

#### **Random Number Generator 542**

Optional random number generator 542 may provide specialized hardware circuitry for generating random values (e.g., from inherently unpredictable physical processes such as quantum noise). Such random values are particularly useful for constructing encryption keys or unique identifiers, and for

initializing the generation of pseudo-random sequences. Random number generator 542 may produce values of any convenient length, including as small as a single bit per use. A random number of arbitrary size may be constructed by concatenating values produced by random number generator 542. A cryptographically strong pseudo-random sequence may be generated from a random key and seed generated with random number generator 542 and repeated encryption either with the encrypt/decrypt engine 522 or cryptographic algorithms in SPU 500. Such sequences may be used, for example, in private headers to frustrate efforts to determine an encryption key through cryptanalysis.

#### **Arithmetic Accelerator 544**

An optional arithmetic accelerator 544 may be provided within an SPU 500 in the form of hardware circuitry that can rapidly perform mathematical calculations such as multiplication and exponentiation involving large numbers. These calculations can, for example, be requested by microprocessor 520 or encrypt/decrypt engine 522, to assist in the computations required for certain asymmetric encryption/decryption operations. Such arithmetic accelerators are well-known to those

skilled in the art. In some implementations, a separate arithmetic accelerator 544 may be omitted and any necessary calculations may be performed by microprocessor 520 under software control.

5

### **DMA Controller 526**

DMA controller 526 controls information transfers over address/data bus 536 without requiring microprocessor 520 to process each individual data transfer. Typically, microprocessor 10 520 may write to DMA controller 526 target and destination addresses and the number of bytes to transfer, and DMA controller 526 may then automatically transfer a block of data between components of SPU 500 (e.g., from ROM 532 to RAM 534, between encrypt/decrypt engine 522 and RAM 534, between 15 bus interface unit 530 and RAM 534, etc.). DMA controller 526 may have multiple channels to handle multiple transfers simultaneously. In some implementations, a separate DMA controller 526 may be omitted, and any necessary data movements may be performed by microprocessor 520 under 20 software control.

### **Bus Interface Unit (BIU) 530**



Bus interface unit (BIU) 530 communicates information between SPU 500 and the outside world across the security barrier 502. BIU 530 shown in Figure 9 plus appropriate driver software may comprise the "appliance link" 510 shown in Figure 6. Bus interface unit 530 may be modelled after a USART or PCI bus interface in the preferred embodiment. In this example, BIU 530 connects SPU 500 to electronic appliance system bus 653 shown in Figure 8. BIU 530 is designed to prevent unauthorized access to internal components within SPU 500 and their contents. It does this by only allowing signals associated with an SPU 500 to be processed by control programs running on microprocessor 520 and not supporting direct access to the internal elements of an SPU 500.

#### **Memory Management Unit 540**

Memory Management Unit (MMU) 540, if present, provides hardware support for memory management and virtual memory management functions. It may also provide heightened security by enforcing hardware compartmentalization of the secure execution space (e.g., to prevent a less trusted task from modifying a more trusted task). More details are provided below

in connection with a discussion of the architecture of a Secure Processing Environment ("SPE") 503 supported by SPU 500.

MMU 540 may also provide hardware-level support  
5 functions related to memory management such as, for example,  
address mapping.

#### **SPU Memory Architecture**

In the preferred embodiment, SPU 500 uses three general  
10 kinds of memory:

- (1) internal ROM 532;
- (2) internal RAM 534; and
- (3) external memory (typically RAM and/or disk supplied  
by a host electronic appliance).

15

The internal ROM 532 and RAM 534 within SPU 500  
provide a secure operating environment and execution space.  
Because of cost limitations, chip fabrication size, complexity and  
other limitations, it may not be possible to provide sufficient  
20 memory within SPU 500 to store all information that an SPU  
needs to process in a secure manner. Due to the practical limits  
on the amount of ROM 532 and RAM 534 that may be included

within SPU 500, SPU 500 may store information in memory external to it, and move this information into and out of its secure internal memory space on an as needed basis. In these cases, secure processing steps performed by an SPU typically must be segmented into small, securely packaged elements that may be "paged in" and "paged out" of the limited available internal memory space. Memory external to an SPU 500 may not be secure. Since the external memory may not be secure, SPU 500 may encrypt and cryptographically seal code and other information before storing it in external memory. Similarly, SPU 500 must typically decrypt code and other information obtained from external memory in encrypted form before processing (e.g., executing) based on it. In the preferred embodiment, there are two general approaches used to address potential memory limitations in a SPU 500. In the first case, the small, securely packaged elements represent information contained in secure database 610. In the second case, such elements may represent protected (e.g., encrypted) virtual memory pages. Although virtual memory pages may correspond to information elements stored in secure database 610, this is not required in this example of a SPU memory architecture.

The following is a more detailed discussion of each of these three SPU memory resources.

#### **SPU Internal ROM**

5           SPU 500 read only memory (ROM) 532 or comparable purpose device provides secure internal non-volatile storage for certain programs and other information. For example, ROM 532 may store "kernel" programs such as SPU control firmware 508 and, if desired, encryption key information and certain  
10       fundamental "load modules." The "kernel" programs, load module information, and encryption key information enable the control of certain basic functions of the SPU 500. Those components that are at least in part dependent on device configuration (e.g., POST, memory allocation, and a dispatcher)  
15       may be loaded in ROM 532 along with additional load modules that have been determined to be required for specific installations or applications.

          In the preferred embodiment, ROM 532 may comprise a  
20       combination of a masked ROM 532a and an EEPROM and/or equivalent "flash" memory 532b. EEPROM or flash memory 532b is used to store items that need to be updated and/or

initialized, such as for example, certain encryption keys. An additional benefit of providing EEPROM and/or flash memory 532b is the ability to optimize any load modules and library functions persistently stored within SPU 500 based on typical usage at a specific site. Although these items could also be stored in NVRAM 534b, EEPROM and/or flash memory 532b may be more cost effective.

Masked ROM 532a may cost less than flash and/or EEPROM 532b, and can be used to store permanent portions of SPU software/firmware. Such permanent portions may include, for example, code that interfaces to hardware elements such as the RTC 528, encryption/decryption engine 522, interrupt handlers, key generators, etc. Some of the operating system, library calls, libraries, and many of the core services provided by SPU 500 may also be in masked ROM 532a. In addition, some of the more commonly used executables are also good candidates for inclusion in masked ROM 532a. Items that need to be updated or that need to disappear when power is removed from SPU 500 should not be stored in masked ROM 532a.

Under some circumstances, RAM 534a and/or NVRAM 534b (NVRAM 534b may, for example, be constantly powered conventional RAM) may perform at least part of the role of ROM 532.

5

#### **SPU Internal RAM**

SPU 500 general purpose RAM 534 provides, among other things, secure execution space for secure processes. In the preferred embodiment, RAM 534 is comprised of different types of RAM such as a combination of high-speed RAM 534a and an NVRAM ("non-volatile RAM") 534b. RAM 534a may be volatile, while NVRAM 534b is preferably battery backed or otherwise arranged so as to be non-volatile (i.e., it does not lose its contents when power is turned off).

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High-speed RAM 534a stores active code to be executed and associated data structures.

NVRAM 534b preferably contains certain keys and summary values that are preloaded as part of an initialization process in which SPU 500 communicates with a VDE administrator, and may also store changeable or changing

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information associated with the operation of SPU 500. For security reasons, certain highly sensitive information (e.g., certain load modules and certain encryption key related information such as internally generated private keys) needs to be loaded into or generated internally by SPU 500 from time to time but, once loaded or generated internally, should never leave the SPU. In this preferred embodiment, the SPU 500 non-volatile random access memory (NVRAM) 534b may be used for securely storing such highly sensitive information. NVRAM 534b is also used by SPU 500 to store data that may change frequently but which preferably should not be lost in a power down or power fail mode.

NVRAM 534b is preferably a flash memory array, but may in addition or alternatively be electrically erasable programmable read only memory (EEPROM), static RAM (SRAM), bubble memory, three dimensional holographic or other electro-optical memory, or the like, or any other writable (e.g., randomly accessible) non-volatile memory of sufficient speed and cost-effectiveness.

#### **SPU External Memory**

The SPU 500 can store certain information on memory devices external to the SPU. If available, electronic appliance 600 memory can also be used to support any device external portions of SPU 500 software. Certain advantages may be gained by  
5 allowing the SPU 500 to use external memory. As one example, memory internal to SPU 500 may be reduced in size by using non-volatile read/write memory in the host electronic appliance 600 such as a non-volatile portion of RAM 656 and/or ROM 658.

10 Such external memory may be used to store SPU programs, data and/or other information. For example, a VDE control program may be, at least in part, loaded into the memory and communicated to and decrypted within SPU 500 prior to execution. Such control programs may be re-encrypted and  
15 communicated back to external memory where they may be stored for later execution by SPU 500. "Kernel" programs and/or some or all of the non-kernel "load modules" may be stored by SPU 500 in memory external to it. Since a secure database 610 may be relatively large, SPU 500 can store some or all of secure  
20 database 610 in external memory and call portions into the SPU 500 as needed.



As mentioned above, memory external to SPU 500 may not be secure. Therefore, when security is required, SPU 500 must encrypt secure information before writing it to external memory, and decrypt secure information read from external memory before using it. Inasmuch as the encryption layer relies on secure processes and information (e.g., encryption algorithms and keys) present within SPU 500, the encryption layer effectively "extends" the SPU security barrier 502 to protect information the SPU 500 stores in memory external to it.

SPU 500 can use a wide variety of different types of external memory. For example, external memory may comprise electronic appliance secondary storage 652 such as a disk; external EEPROM or flash memory 658; and/or external RAM 656. External RAM 656 may comprise an external nonvolatile (e.g. constantly powered) RAM and/or cache RAM.

Using external RAM local to SPU 500 can significantly improve access times to information stored externally to an SPU. For example, external RAM may be used:

C to buffer memory image pages and data structures prior to their storage in flash memory or on an external hard disk

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